THE MARINE REVIEW

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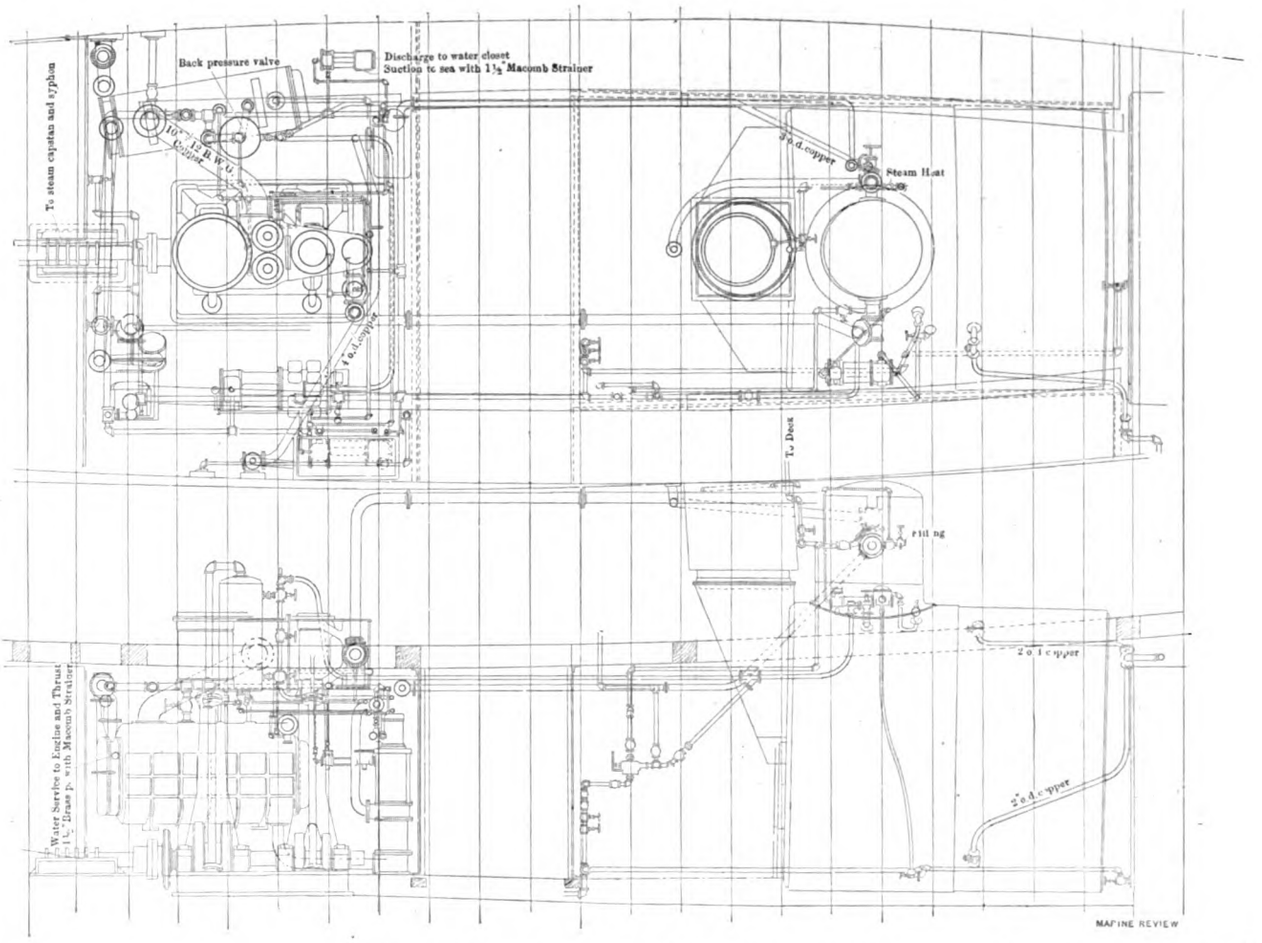
TRIAL OF TUG ORION.

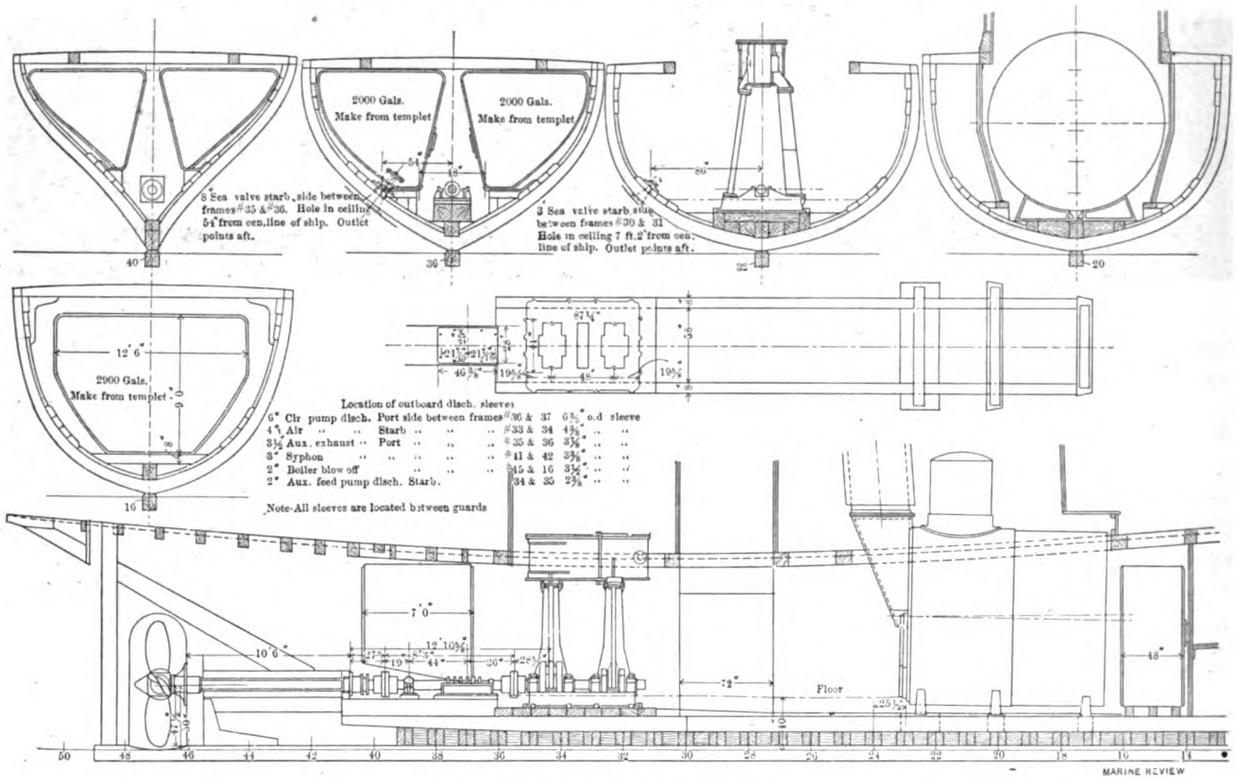
In the recent endurance speed trial of the tug Orion, built by the Portland Co. for the Boston Tow Boat Co., the tug reached a speed of 13½ knots, her engines developing 580.88 H. P. The Orion was designed by R. P. Simpson of the firm of B. B. Crowninshield of Boston. The Orion is 102 ft. over all, 19 ft. 6 in.-beam and 11 ft. 6 in. deep. She is equipped with a vertical fore and aft compound engine with cylinders 15 and 32-in. diameter by 22-in. stroke, supplied with steam from a Scotch boiler, 11 ft. 3-in. diameter and 12 ft. long. The tug is equipped with three Morrison suspension furnaces, steam heating system, ventilating system, and a complete equipment of pumps. The hull was built in the yard of the Portland Ship Building Co., South Portland, Me. The keel is of white oak, 10 by 10 in., the stern part of the same material and the same size, and the stem is of white oak, 10 by 14 in. The frames are of white oak molded 10 in. and spaced 24-in. centers. The deck beams are of hard pine. The outside planking is of white oak, 2½ in. thick. The deck is laid with 2¾ by 2¾-in. Oregon pine. The air and feed pumps were supplied by the Warren Marine Pump Co., 95 Liberty street, New York, and the 6-in. circulating pump with a 6 by 6 engine by the Morris Machine Works, Baldwinsville, N. Y.



ARRANGEMENT OF MACHINERY AND PIPING OF TUG ORION.

The two new turbine steamships which are being built at

Roach's ship yard, Chester, Pa., for the Metropolitan Steamship Co., are to be named Yale and Harvard, and are to ply between New York and Boston, taking the outside course via East river and Long Island sound. They will be 400 ft. long, 51-ft. beam at water line and 61 ft. on deck, and 22½ ft. deep from the top of keel to the top of the deck to the side. The machinery for these steamers is being built by the W. & A. Fletcher Co., Hoboken, N. J., and is intended to develop a speed of 23 knots. Each of the steamers will have about 300 staterooms, a capacity for over 1,000 passengers besides 2,000 tons of freight. The staterooms are to be large and airy, much thought being given to perfect ventilation.


2000 Gals. Make from templet
2000 Gals. Make from templet
8" Sea valve starb. side between frames #35 & #36. Hole in ceiling 5' from cen. line of ship. Outlet points aft.
8" Sea valve starb. side between frames #30 & 31. Hole in ceiling 7 ft. 2" from cen. line of ship. Outlet points aft.
12' 6"
2900 Gals. Make from templet
Location of outboard disch. sleeves
6" Clr pump disch. Port side between frames #36 & 37 6⅝" o.d sleeve
4" Air .. .. Starb .. .. .. #33 & 34 4⅝" .. ..
3½" Aux. exhaust .. Port .. .. .. #35 & 36 3⅝" .. ..
3" Syphon .. .. #41 & 42 3⅝" .. ..
2" Boiler blow off .. .. .. #15 & 16 3⅛" .. ..
2" Aux. feed pump disch. Starb. #34 & 35 2⅝" .. ..
Note-All sleeves are located between guards
Floor
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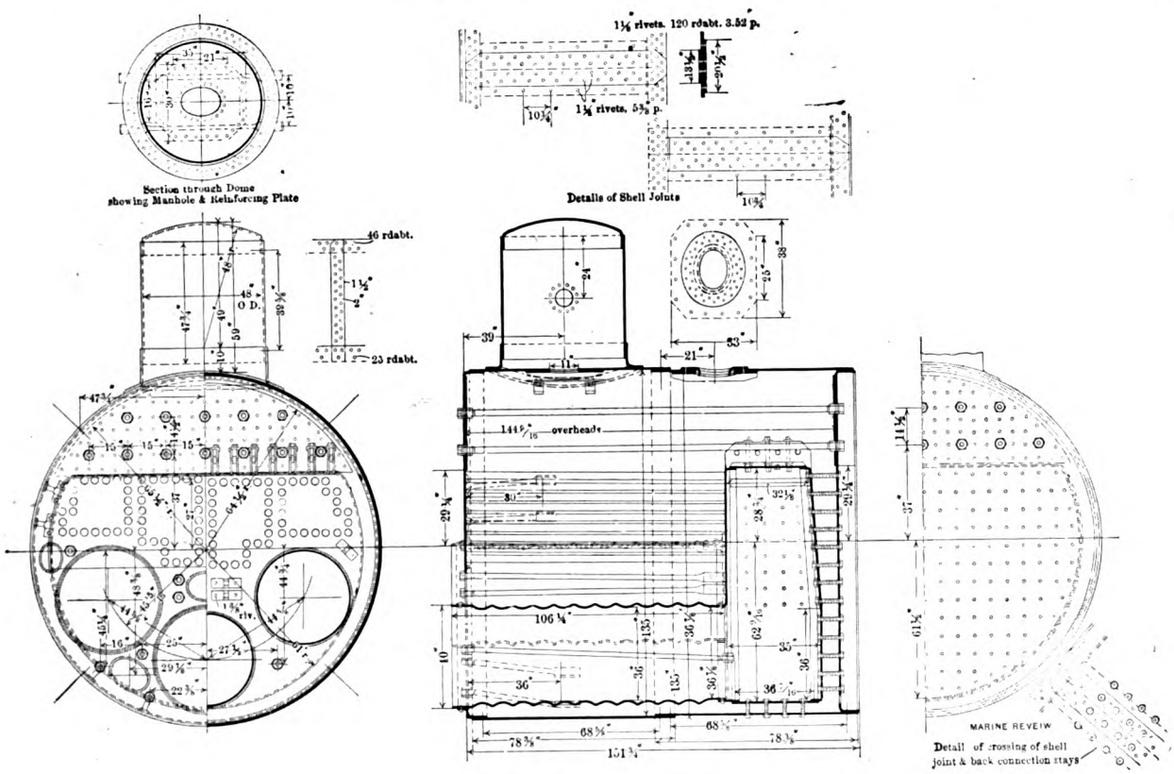
LOCATION OF MACHINERY, TUG ORION.


Section through Dome showing Manhole & Reinforcing Plate
Details of Shell Joints
46 rdabt.
23 rdabt.
overheads
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Detail of crossing of shell joint & back connection stays

BOILER OF THE TUG ORION.

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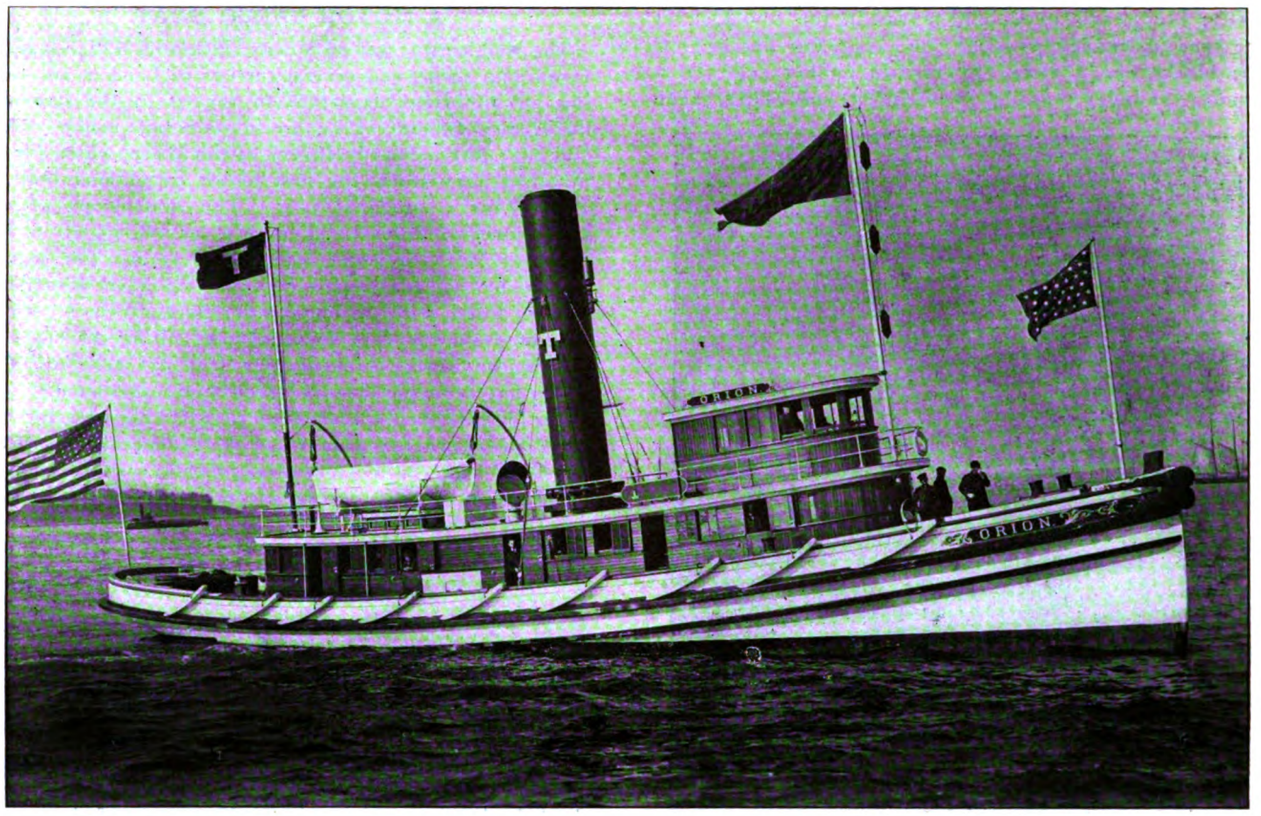


TUG ORION OF THE BOSTON TOWBOAT CO.'S FLEET, BUILT BY THE PORTLAND CO., PORTLAND, ME.

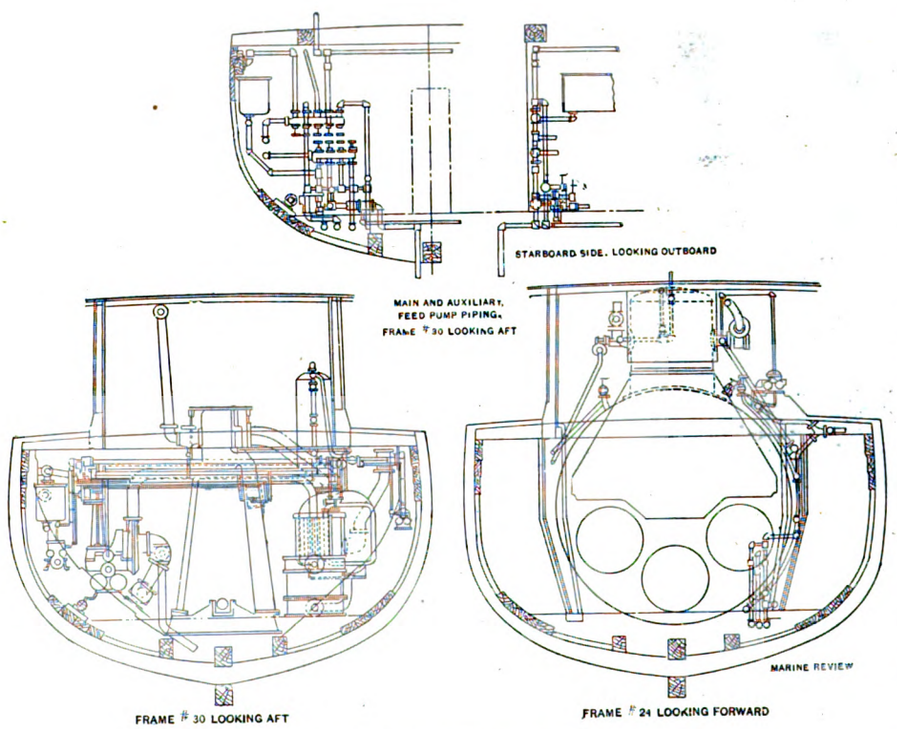
DAMAGE TO SAN FRANCISCO WATER FRONT.

The entire four miles of water front of San Francisco escaped with comparatively small damages from the earthquake—divided about evenly between shock and fire. The total damages have been very carefully estimated by the state authorities. All the water front of the city belongs to the state of California—including the piers and other improvements. Gov. Pardee has just filed his report in regard to the losses sustained by the recent disaster. The total loss reaches $600,700.

The heavy shock caused the sudden collapse of the roofs of six of the large and long piers, and caused other damage. These damaged piers were about 100 ft. wide and extended out from the shore for distances ranging from 300 to 600 ft. None of the docks that collapsed was two stories in height. All these piers will soon be repaired, strengthened and new roofs built.

What is known as the "sea wall" or the "old Meiggs' wharf," along the northeastern water front, was totally destroyed by fire. The wharf proper was about 1,500 ft. long and 100 ft. wide. It was used principally for storing grain and flour. Considerable quantities of grain were also burned. The fire extended for a quarter of a mile or more westward along North Beach, but there were no valuable wharves in that part of the water front. Fortunately, no vessels were burned or seriously damaged by the fire.

Very heavy damages were suffered by the Union Iron Works. Two new and very large steel steamships were fairly under way, the keels having been laid several months ago. So great was the shock that the unfinished keels were knocked clear off from the blocking.


STARBOARD SIDE. LOOKING OUTBOARD
MAIN AND AUXILIARY FEED PUMP PIPING. FRAME # 30 LOOKING AFT
FRAME # 30 LOOKING AFT
FRAME # 24 LOOKING FORWARD
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ENGINE AND FIRE ROOM SECTIONS, TOWBOAT ORION.

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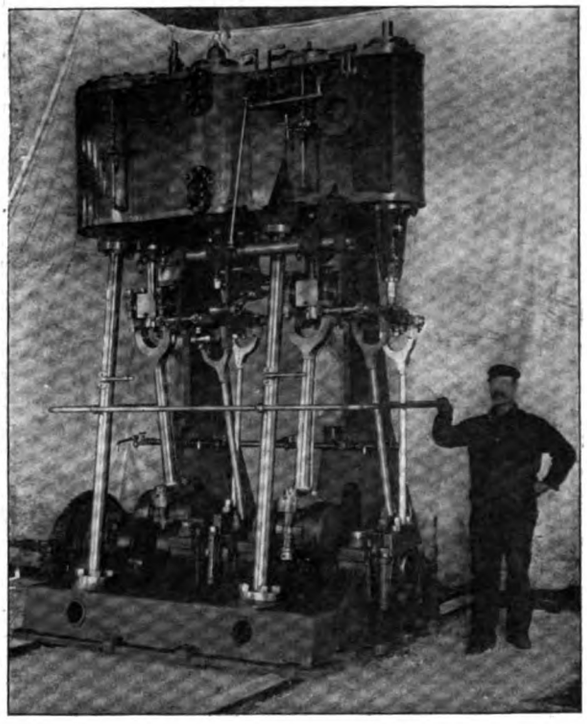
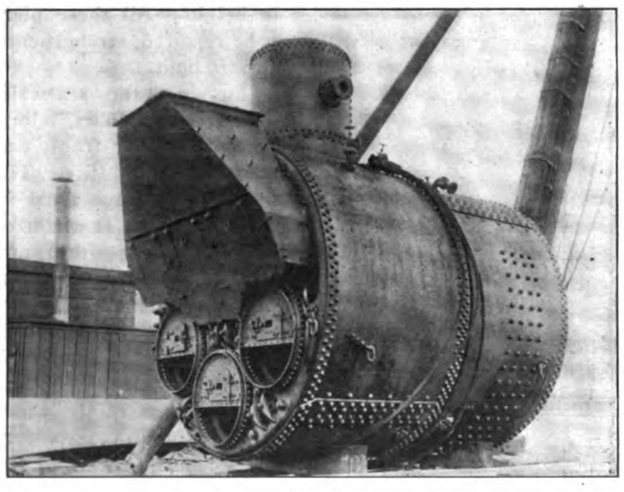
The big steamship Columbia was in the dry dock at the time undergoing repairs. The vessel was knocked off the blocks like a mere toy, thrown on her side and a number of holes punched through her hull plates. The



ENGINE OF THE TUG ORION.

whole gearing of the immense dry dock was damaged, and the flooring sunk several yards into the water, thus causing the steamship hull to half fill. To repair the dock, raise and repair the damages to the Columbia will cost a large sum. The large steamship City of Pueblo which was lying alongside of one of the docks of the Union Iron Works undergoing repairs met with a serious disaster.



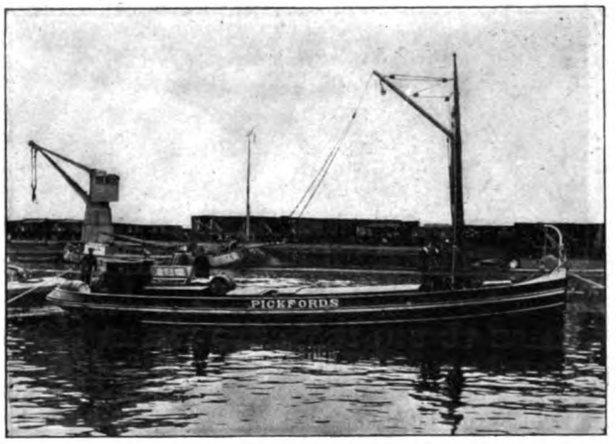
BOILER OF THE TUG ORION.

One of the immense iron cranes was thrown down, and falling directly across the deck of the vessels, smashed the wood work and cut down nearly to the water line. The vessel very narrowly escaped sinking.

Walter Metcalf, the diver, has bought the wreck of the schooner Algeria which foundered in Lake Erie a fortnight ago and will remove her cargo of iron ore.

A MOTOR CARGO BOAT.

The well-known firm of Messrs. Pickfords, Ltd., shipping, forwarding agents and general carriers of London, are making an important departure in regard to the immense traffic they handle. They are introducing motor boats, and have just received delivery of the Wasp, which for all practical purposes is the first motor cargo boat built in Britain for commercial uses. The dimensions of the Wasp are as follows: Length over all, 55 ft. 6 in.; beam, 12 ft. 3½ in.; and draught 3 ft. 3 in. The boat is driven by a 24-horsepower single cylinder Kromhout motor, fitted with 24-horsepower motor winch, which worked from the deck is capable of lifting packages of half a ton at the rate of four feet per second. The Wasp has been specially designed and constructed to the order of this well-known firm of carriers, who for 300 years have been the pioneers of every improvement that has been made in the means of quick transit. The new craft in which great interest is taken by engineers and



A MOTOR CARGO BOAT.

commercial people generally, will take her place amongst the firm's south of England cargo steamers from Plymouth, Southampton, and the Isle of Wight, and her behavior as against these will be watched with no little interest, not to say curiosity.

In addition to floating the steamer Eugene Zimmerman, Capt. Thomas Donnelly has during the past few weeks put the Canadian steamer Iroquois in dry dock at Collinwood, attended to the Midland Queen collision with the William G. Mather, and is now supervising the repairs to the steamer Huronic which stranded in the St. Mary's river—a truly busy existence.

The steamer John Duncan which was in collision with the steamer Wisconsin near Amherstburg was released by the tug Brockway after 100 tons of her cargo had been lightered by the Newman. She was not seriously damaged.

The Southern Railway Co. has purchased the old Trigg ship yard property at Richmond, Va., for extension of its local track and warehouse facilities. The property covers sixteen acres of land lying between the city docks and the James river.

Percy & Small, Bath, Me., are building a six-masted schooner for J. S. Winslow & Co., of Portland, to be ready in August. She is to be 306 ft. over all, 285-ft. keel, 48-ft. beam and 27 ft. deep.

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ARMORCLADS AND WATERCLADS.

The current naval appropriation bill provides for one large battleship, three large oversea destroyers, and $1,000,000 for subsurface or submarine boats to be purchased or contracted for in the discretion of the secretary of the navy.

This bill shows the careful study that our navy department and congress have given to the principal lessons of the Russian-Japanese war and the increasing range and efficiency of torpedoes.

The Japanese armies could not safely invade Russian territory until Japan gained command of the sea threatened by the Russian battleships.

The seagoing Japanese torpedo boats in their initial night attack on the Russian fleet in Port Arthur, sank enough of the Russian ships to establish the supremacy of the Japanese fleet, without risking the Japanese battleships under the fire of the fortifications and over the mine fields of that port.

In the decisive conflict of the Sea of Japan, the better handled Japanese ships kept out of torpedo range and medium gun range of the Russians and with their large guns and superior gunnery battered, disabled and demoralized them throughout the day until, when night fell, it was possible for the Japanese torpedo boats under cover of darkness, to attack and complete the destruction.

The vessels that thus decided the issue of the war were the seagoing Japanese armorclads and torpedo boats, which could follow and concentrate their united strength against the Russian fleet, with the Japanese destroyers which, with their rapid-fire guns, kept off the inferior Russian torpedo boats and destroyers.

The fortifications and mines of Port Arthur and Vladivostock, as at Santiago, effectually barred the enemy's fleet; and Port Arthur, like Santiago, fell only to a land attack, after the command of the sea was lost and the way to invasion opened through an unprotected part of the coast.

The Russian submarines in the Baltic and the Black seas and the Japanese submarines in the Japanese harbors, did and could do nothing for their respective sides, as their inherent slowness, lack of seagoing ability and cruising radius, prevented them from accompanying their respective fleets and following the enemy, and also from crossing the sea into the enemy's port, as did the Japanese torpedo boats into Port Arthur.

The Russian ships with their rapid-fire guns, easily kept off the unprotected Japanese torpedo boats by day.

Summing up these facts, we learn as has our president, our navy department and our congress, as well as foreign powers, that the best fighting ship is not "the ship that can get in and out of the fighting the soonest, but the ship that can stay in the fighting the longest." That the only weapons that can wrest victory from battleships are better or better manned battleships, and torpedo boats large enough and fast enough to take the offensive with other vessels, yet small enough to attack by surprise at night, or in the confusion of the battle. That the battleship should be large enough to carry the largest battery of the heaviest guns for fighting large vessels at long range, and a numerous battery of small rapid-fire guns for keeping torpedo boats out of torpedo range. That the armor of the battleships should be able to keep the largest shells, and should cover not only the large guns, their crews and all vulnerable parts, but also—what has not yet been deemed necessary—enough at least of the small guns and their crews to protect them from large shells and thus preserve them for use against torpedo boats.

These requirements, save the last, are, so far as known, met in the design of the new British battleship Dreadnaught, and doubtless will be met in the design of the new 20,000-ton battleship authorized in our naval bill.

For additional protection against, and the chase of torpedo boats and destroyers, larger and faster destroyers, with a more powerful battery of rapid-fire guns, are extremely desirable, as recognized by the conspicuous target for large guns as well as small, unfits them for use against armorclads or even cruisers.

The seagoing torpedo boat has fully regained and earned its prestige as a valuable offensive weapon against battleships and other large vessels, under cover of night or other conditions favoring surprise, or after the latter's small batteries and personnel have been overwhelmed by superior gun fire. But the easy vulnerability of unprotected torpedo boats to rapid-fire and machine guns under normal conditions has been again established, and must be remedied before the torpedo boat can take the place in the first or even second fighting line to which the great range and efficiency of the modern torpedo entitles it.

As torpedo boats small enough to avoid large gun fire cannot carry the weight of sufficient armor, the protection of the element surrounding it is the only recourse.

It is this that has led the navy department to suggest, and congress in the naval bill to make an appropriation of $1,000,000 for subsurface or submarine torpedo boats, to be selected by the secretary of the navy, these being the two principal classes of water-protected torpedo boats.

The importance of securing an effective boat for the American navy is shown by the fact that Great Britain will be able shortly to bring against the 40 present and prospective battleships and armored cruisers and 48 torpedo boats of the United States, divided between the Atlantic and Pacific, 100 armorclads and 253 torpedo boats (including destroyers); France, 66 armorclads and 359 torpedo boats; Germany, 45 armorclads and 133 torpedo boats; and Japan, against our small Pacific division, 29 armorclads and 129 torpedo boats.

Either the Atlantic or Pacific divisions of our fleet will be at the mercy of the concentrated fleets of either of these powers until our fighting strength is increased by at least 25 large armorclads, which is evidently impracticable, or by an equivalent number of torpedo boats that can go and fight with our armorclads.

Purely harbor defense submarines would not in any way fill the gap. In fact, for the purpose of the United States, with its enormous unprotected coast line and hundreds of ports, any harbor defense craft, whether monitors or submarines, confined to one base, are undesirable, because, not knowing where an enemy will strike, all our ports and unprotected places would have to be equipped with them, at an enormous cost, which would buy infinitely more value in mobile armorclads and torpedo boats.

Large submarines of 150 to 175 ft. in length, like those Great Britain and France are building, might be used offensively as protected torpedo boats, running under the surface, with their conning tower by night or periscope by day exposed to gain vision. But to obtain the additional quality of complete disappearance, which is useless to attack a moving vessel because vision is lost, they have necessarily sacrificed, (1) their speed, which is less than one-half that of the vessel they should fight or accompany; (2) reserve buoyancy and thus safety, as shown by the frequent and terrible disasters to submarines from the accidental admission of water; (3) cruising ability, which is about one-tenth of that of other vessels; (4)

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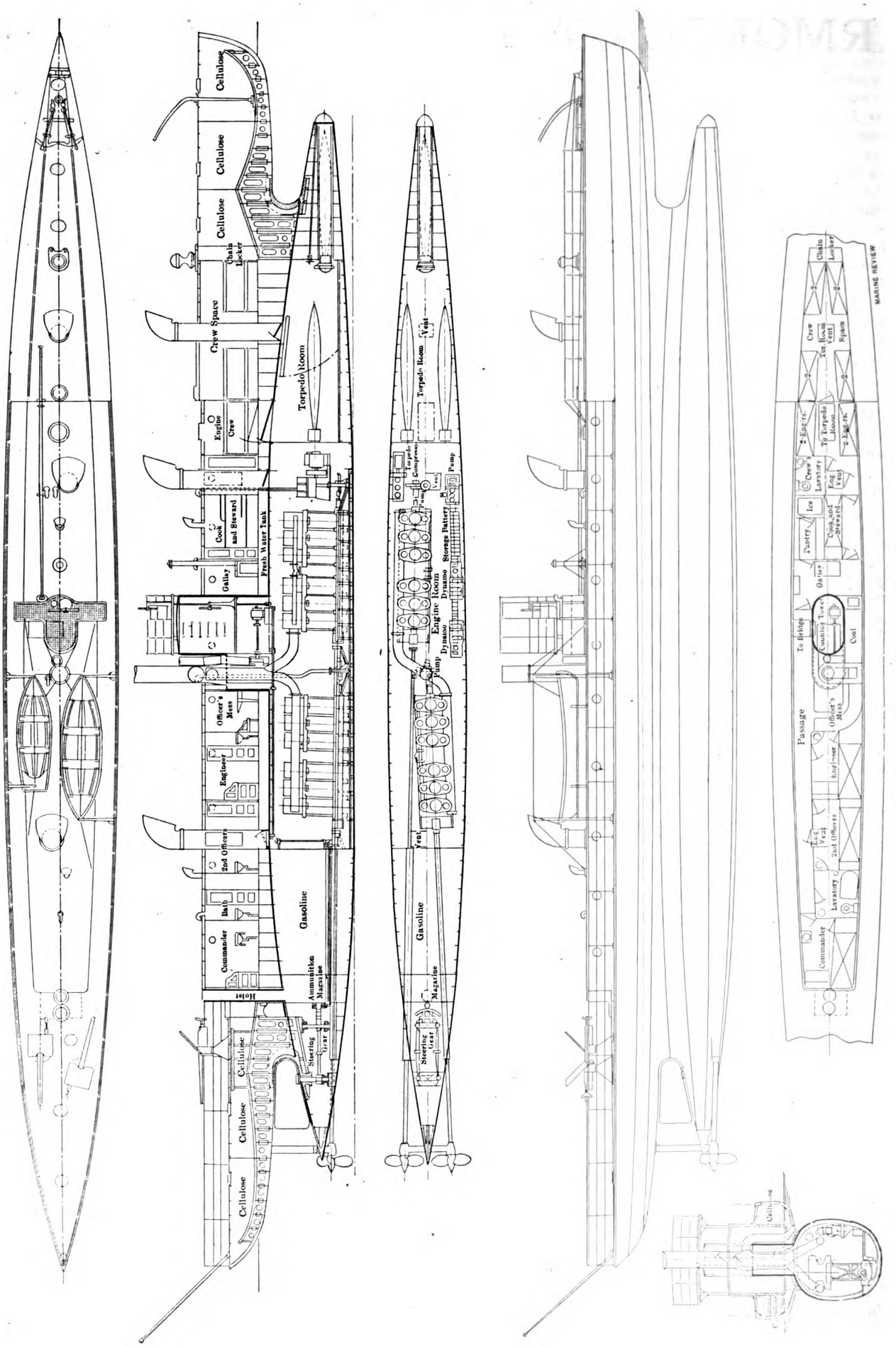

GENERAL PLAN OF THE SUBSURFACE TORPEDO BOAT.

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habitability, the lack of which necessitates accompanying torpedo boats as house boats or "nurses" and (5) the rapid-fire battery so essential for defense against torpedo boats and destroyers.

The subsurface boat first mentioned in the torpedo boat clause of our naval bill, with submarines as an alternative, is not familiar to the general reader like the battleship and submarine. Through the courtesy of Mr. W. I. Babcock, now vice president and general manager of the Subsurface Torpedo Boat Co., of New York, which owns the American and foreign rights to this double-hull boat, we are able to present detail plans of the 20-knot 140-ft. L. W. L. seagoing subsurface torpedo boat, which is to be built for trial under the $1,000,000 appropriation.

The Bath Iron Works, the well-known torpedo boat builders, having recently tested on Long Island sound a smaller boat on the same lines, is under contract to guarantee for this 140-foot boat; "(1) a speed exceeding 19 knots; (2) a cruising radius of 2,000 nautical miles on 10 knots; (3) a turning circle at full speed of not more than 250 yds. diameter; (4) a turning period at full speed not to exceed 1¼ minutes, and (5) an ability to keep the seat at least equal to ordinary torpedo boats of her size."

It will be seen from the plans that the subsurface torpedo boat is simply a submarine boat running just under the surface, with a heavily armored conning tower always high above the water to give air and clear vision, the whole being supported by a distinct surface hull, which is filled with cellulose in compartments, so as to preserve the buoyancy, stability, vision, air supply, and thus the efficiency of the whole boat even if the exposed hull should be riddled with shot.

The submerged hull containing the internal combustion engines and steering gear, the torpedo tube and torpedoes, the oil or gasoline for fuel, the ammunition for the rapid-fire guns, the lighting and ventilating plant, and all other vitals, being totally submerged at all times is perfectly protected from direct gun fire, and also from the effect of possible shell explosions in the exposed hull, by the water between the two hulls and an armored deck separating the two hulls at the waist connecting them.

From this armored deck rises high above the upper deck the heavily amored conning tower, containing the steering wheel and signals to the engine and torpedo room, from which conning tower the commander has perfect vision to direct the boat's operations. This conning tower is proof against rapid-fire guns and is too small to be hit by larger guns. Through this armored conning tower also rises the main air shaft terminating in a high stack, through which the foul air and any stray gasoline vapors, drawn through perforated pipes along the bottom of the torpedo and engine rooms, are expelled by an electrically driven blower. The fresh air for ventilation and engine combustion is taken in through the openings in the conning tower when in action, and through auxiliary deck ventilators leading down into the engine and torpedo rooms, when not in action. These auxiliary ventilators serve also as auxiliary escapes for the crew and can be closed when in action by armored hatches in the armored deck.

The exhaust for the engines is led upward into the air stack so as to assist in expelling the foul air, when the engines are running. An auxiliary under-water exhaust is also fitted for more perfect silence when necessary. An armored ammunition hoist leads upward from the magazine to the deck near the rapid-fire guns aft.

The forward and after parts of the surface hull and both sides amidships are completely fitted with cellulose. Between the side cellulose compartments are arranged comfortable quarters, a galley etc., naturally lighted and ventilated, for the officers and crew when the boat is not actually engaged in action.

When in action the crew are all in the submerged hull, so that shells can pass through the upper hull without materially affecting boat or crew, the cellulose acting to close up the shot holes and keep out the water.

As each hull is designed so as to be stable and buoyant by itself, the greater part of the exposed hull could, if it were possible, be shot away without destroying the buoyancy, stability or efficiency of the submerged torpedo boat.

Over the conning tower is fixed a bridge with a duplicate steering wheel, signals, etc., for the commander when not in action, or whenever its use is advisable.

The offensive armament consists of a bow torpedo tube and three 21-inch Bliss torpedoes, having a range of 3,500 to 5,000 yards and a speed of 35 knots.

The rapid-fire guns on the upper deck—in the case of this 140-ft. boat, two 6-pounders—serve, as on an ordinary torpedo boat, for keeping at a distance hostile torpedo boats and destroyers, which can be easily put out of action by these guns, but whose own guns cannot hurt the subsurface boat. The upper hull also, as on an ordinary torpedo boat, affords the usual conveniences for stowing boat, anchors, etc., for a folding military mast, and for exercising the crew.

The beam of the upper hull of the 140-ft. boat illustrated is 13 ft. 6 in. and the draught is 11 ft., the headroom in both hulls being ample. The two 6-cylinder Standard engines of 1,500 guaranteed B. H. P. each, will, according to the recent tests of the small subsurface boat and of the five models tested in the government's experimental basin at Washington, give a speed of 20 knots. Larger subsurface boats, like surface boats, will have greater speed.

The cruising radius, maneuvering ability, habitability, sea-keeping ability, etc., as tested and guaranteed by the Bath Iron Works, are close to the requirements for ordinary unprotected torpedo boats of the same size.

To sum up, it will be seen:

(1) That the value of the complete-disappearance quality of the pure submarine is largely imaginary owing to its complete loss of vision when under water, the visibility of the periscope by day, and its absolute uselessness by night.

(2) That the wave and fuss raised by the submarine when running submerged, with its conning tower above water, makes the submarine more visible by night or by day than the exposed hull of the subsurface boat, which on trial made very little disturbance in the water.

(3) That the vision from the low conning tower of the submarine when running awash is constantly obscured by the waves, and

(4) That the complete-disappearance quality of the submarine is gained at too great a sacrifice of speed, seakeeping ability, safety, habitability, economy and defensive armament.

The subsurface boat has, on the other hand, sacrificed only the doubtful or valueless disappearing quality of the submarine. It has retained its valuable invulnerability when running submerged, while restoring to it the high speed, the clear vision, seakeeping ability, safety, habitability, defensive armament and simplicity of the ordinary torpedo boat. The slightly inferior speed of the subsurface boat to the surface boat is additionally compensated for by the fact that, owing to its necessarily larger displacement, the hull, engines and fittings of the subsurface boat can be and are made of unusual strength and weight, without using up the available displacement.

The subsurface torpedo boat is thus free from the two

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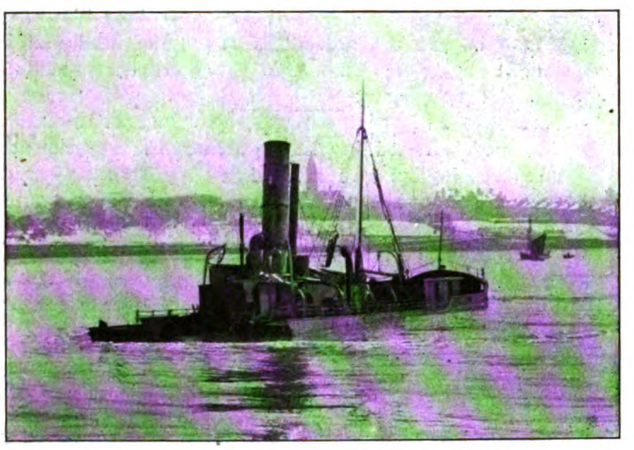
great faults of the surface torpedo boat—the easy vulnerability to rapid-fire and machine guns, and the extreme frailty and liability to damage,—while its speed is ample to enable it to co-operate with other fighting vessels. Further, neither at Port Arthur nor on the Japan Sea was a speed exceeding that of the subsurface boat needed or used, as the vessels attacked were either stationary or moving at a much lower speed, and it is well known that at a speed exceeding 20 knots, torpedoes cannot be fired with any accuracy, and the high bow wave makes the torpedo boat very conspicuous.

The Waterclad subsurface boat has thus conceded to the unprotected surface torpedo boat, as has the armorclad battleship to the unprotected cruiser, a few nonessential knots in speed for the overwhelming advantage of invulnerability.

A BIG SALVAGE FEAT AT LIVERPOOL.

The Houston liner Fearless, while proceeding down the Mersey, outward for Hamburg, collided with the coasting steamer Patricia, outward bound from Garston to Dublin. The Fearless was struck amidships and considerably damaged, so much so, that she had to be beached in sinking condition. As she took the ground some time before high water, her decks were covered during a cer-

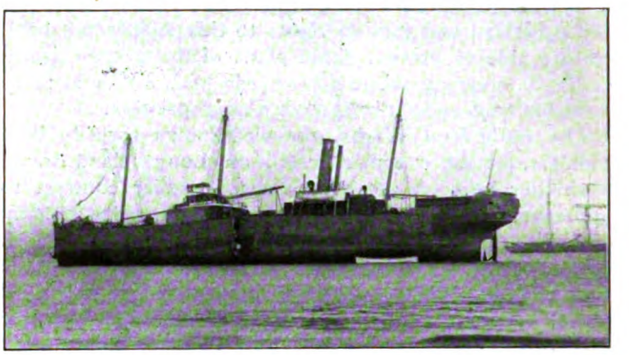


AFTER END OF FEARLESS TOWARDS HIGH WATER.

tain portion of the tide, and a strong current runs on the Cheshire side of the river where she was beached. This rendered the subsequent salvage operations considerably more difficult. While efforts were being made to

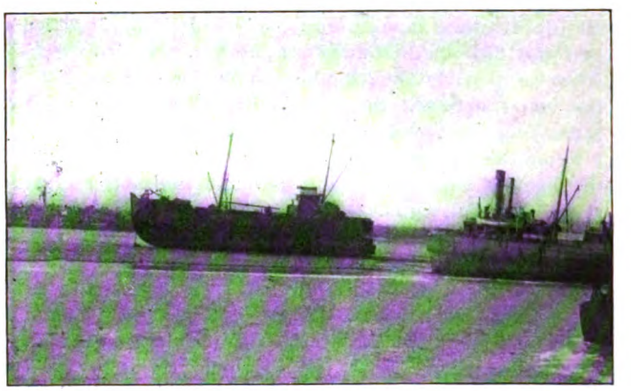
AFTER END OF THE FEARLESS BEING FLOATED AND TOWED UP THE RIVER MERSEY. SALVAGE STEAMER ALONGSIDE.

discharge some of the cargo, the steamer broke her back through lying across a ridge, an accident which made the work of removing the ship in one piece practically impossible. The Fearless, therefore, had to be cut in two. This task was a most awkward one, for a fracture existed on the starboard side about 30 ft. abaft the rupture on the port side made by the collision, leaving 13 frame spaces intact. As the water in the Mersey is impenetrable to rays of light, the cutting of the unbroken portion was most difficult, and the result uncertain. This task was accomplished by means of gelignite and tools. This work was done by the Liverpool Salvage Association's



FEARLESS WITH BACKBONE BROKEN.

officer, Capt. F. W. Young, who at once directed a stout plank bulkhead to be built across the forward portion of the hull, which was also the greater half, and strongly supported by immense cross pieces of timber, so as to be intact and watertight, and the lower portion built in by divers. Precautions had also to be taken to prevent this portion of the wreck capsizing, for the four powerful salvage pumps that had been placed on the deck, had interfered greatly with her stability, and all possible top weights were lowered or removed. Much of the cargo



FORWARD END OF FEARLESS BEACHED AFTER FLOATING.

having been removed from the holds, a large quantity of stone ballast had to be used to keep the vessel upright. All preparations having been made for finally separating the two portions of the ship off the ridge on which they lay, and four tugs made fast for the purpose of towing when the pumps had given the larger of the ship buoyancy, the four pumps consisting of a 12-in., two 10-in. and one 8-in. having a capacity equal to about 2,650 tons an hour were set going, and in a very short time evidence was forthcoming that the splendid work put into the bulkhead had been effective, and further that the bottom was practically intact after the tugs had pulled a short time, together with the wreck regaining buoyancy, there was a sudden crack, a pump of the after end of the fore part of the vessel, and a very decided list to starboard towards the salvage vessel Ranger. This movement of the ship was the signal for the divers and others who had worked so strenuously for weeks to get the vessel afloat.

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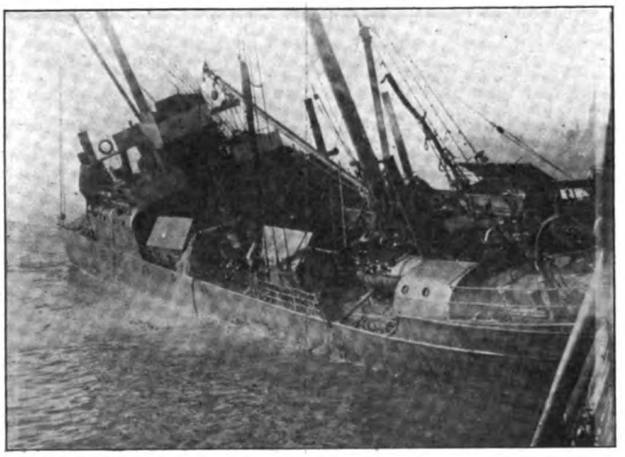
to give a rousing cheer, for this solved the problem as to whether the separation had been effectually done. Gradually the gap between the forward and after ends of the Fearless widened, and the list became more pronounced, but before she could have been towed successfully round for beaching to Tranmere, some three miles up the river,

AFTER END OF FEARLESS AT HIGH WATER.

the salvors saw that perhaps very serious trouble would have attended the maneuver, as the vessel got athwart the tide. It seemed at one time as if the Fearless would have fallen on the top of the salvage steamer Ranger, but this tendency was checked by completely emptying the holds of water that then lay in the starboard bilges. An adjustment of the weights having also been made, she was successfully beached, together with the after portion in much the same way, a few days later. It was necessary that this wreck should be removed either in the above manner, or by blowing up, as in the position she lay she was



FORWARD END OF FEARLESS CAPSIZING WHILE BEING TOWED OFF THE BEACH. THIS END WAS PUT ASHORE AGAIN.

a danger to navigation in the river. The Fearless was an iron screw three-masted steamer of 1,750 tons gross register, and 896 tons net. In the admiralty court, the Patricia was pronounced solely to blame for the collision, and damages have just been given against her to the extent of £8 per ton in accordance with the statutory limit. The salvage operations were carried out by Capt. Fred W. Young, M. I. Mech. E. and wreck officers of the Liverpool Salvage Association, whose interesting paper with illustrations on "the Salvage of Ships," appeared in a recent issue of the MARINE REVIEW.

A DIFFICULT REPAIR JOB IN LIVERPOOL.

In the last engineers' number of the MARINE REVIEW, an illustrated article appeared dealing with the salvage of ships by that excellent organization in Liverpool known as the Liverpool Salvage Association. The aim of this institution is to render trained assistance in cases of shipwreck and stranding, and generally to assist in reducing losses by maritime disaster and other causes. A feature of the association is that it does not work for purposes of profit, and is directed by a committee representative of the Liverpool Marine Underwriting offices. Quite recently this salvage association succeeded in rendering some valuable salvage services to the Federal liner Durham, which was run into by the steamer Indian during a fog on March 13, this year, and our illustration has been reproduced from a photograph taken

SALVING THE FEDERAL LINER DURHAM.

at Holyhead, where the steamer was temporarily in the hands of Capt. M'Clellan of the Liverpool Salvage Association, whose skillful patching of the hole enabled the steamer to keep afloat and be brought to Liverpool for repairs. The hole made by the bow of the Indian was 22 ft. wide and 40 ft. deep, and penetrated the fore hold, which was insulated for the carriage of dead meat, the vessel being engaged in that trade. The work of putting the ship in order was entrusted to Messrs. H. and C. Grayson of Liverpool, who secured the contract after competition with a number of ship builders and repairers from Belfast, the Clyde, and the Tyne. Within thirty-five days from taking the ship in hand they have completed this very difficult repair job, and besides built into the ship a new stern frame. Fortunately Messrs. Grayson have a large and well equipped engine works in close proximity to the Birkenhead graving dock, where the Durham was dry-docked, and this helped them materially no doubt in being able to complete the work so quickly. The Durham left the repairers' hands on May 23 to again take her place in the Federal line service. With such a big hole in her side, the wonder is that she is afloat today to resume her regular trading.

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THE MARINE REVIEW

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JUNE 7, 1906.

It should be understood that the course of articles now running in the MARINE REVIEW under the direction of Mr. Clarence E. Long are intended for mariners in general. They are as valuable to the wheelsman and watchman as to the mate and master. It would be well for every young man aboard ship to study these articles. In no way could he fit himself more quickly to take charge of a ship. The lake trade is growing and the demand for competent men is great. Moreover, the prize is well worth winning. There is no better or cleaner work than that aboard a lake ship. Owing to an unusual demand upon our columns, the course is withheld from this week's issue, but a double installment will be published next week.

The superb equipment of the great lakes for the handling of bulk freight was never better demonstrated than during the month of May just closed. Notwithstanding the fact that navigation was practically suspended for nearly two weeks the movement of iron ore was almost as great as that of the corresponding month last year. Even during the brief period that navigation was under way conditions were not normal and there were difficulties, inseparable from the strike, to be surmounted. Nevertheless over 4,000,000 tons of ore were handled, so easily that no one knew that anything special was going on. The physical equipment of the great lakes is doubtless sufficient for any strain that industrial conditions may put upon it.

THE SHIPPING CAMPAIGN.

The campaign in favor of shipping in the foreign trade is being personally conducted by the Merchant Marine League. To this organization is due the general enlightenment of the whole people upon the subject. Through its efforts there have been published in from 800 to 1,000 newspapers weekly, the facts pertaining to American shipping; not arguments in favor of the shipping bill especially, but just the actual facts of the present deplorable condition of American shipping in the foreign field. At no time in the history of this movement has the outlook been so encouraging for favorable action as now. The arguments advanced have certainly been convincing. It is only once in a great while that a newspaper is met with that will not publish the two sides of the question. In its issue of May 16 the *Washington Post* published an editorial to which Mr. Harvey D. Goulder, president of the league, concluded it necessary to reply. As the *Post* declined to publish Mr. Goulder's answer, both its editorial and Mr. Goulder's reply are herewith published in parallel columns.

POST EDITORIAL.

It is said that Mr. Speaker Cannon is unalterably opposed to the ship subsidy, and if that be true the measure will have considerable difficulty in getting into the statutes, for it is a well-known fact that if Uncle Cannon is a hand and a half in promoting legislation, he is two hands and a half in frustrating legislation, especially on the house side. The speaker comes from Vermillion county, and Edgar is within a hop skip, and jump. The Wabash is on the border, and there is where they grow hog and hominy in exuberant abundance, in actual competition with all the beggars in the world and without subsidy.

The speaker is a hard-headed man and a clear-headed man. The best passage in Proctor Knott's Duluth speech would not occasion a smile on the thoughtful countenance of a brass-headed snapping turtle. No more will a lame plea for ship subsidy move the inflexible common sense of Joseph G. Cannon.

We are the greatest exporting nation on earth, and there is not one pound of American freight that has to wait for a boat and that is not carried as cheaply as is the freight of any other nation. If our goods are not carried in American bottoms there are excellent reasons for it—somebody can make a cheaper ship than we and sail it for less. There is a heap of slush that has been orated over the thing. We are told that the farmer fatting pork in Uncle Cannon's district and all the other farmers out there are distressed to death because the stuff they produce and sell is not carried abroad under the American flag. It is doubtful if the farmer cares a rap about it. It is certain that he does not want to be taxed for the flag in that way. You had as well tell him that it is unpatriotic to eat pineapples from Cuba, and ask him for a subsidy to grow pineapples in Connecticut. A subsidy without patriotism is like mendacity with

MR. GOULDER'S REPLY.

We have not replied to your editorials for reasons known to you, but we can hardly let pass without challenge your statement this morning that "there is not one pound of American freight that has to wait for a boat, and that is not carried as cheaply as is the freight of any other nation." The Merchant Marine League, which includes important and diversified interests throughout the country, exists and in every proper way is insistent because the reverse of what you say is true, putting the experience and the views of tens of thousands of intelligent men of affairs against your unsupported statement.

American manufacturers and merchants interested in export trade told the Merchant Marine Commission that foreign ships do not give them as regular service and as favorable rates as are given to manufacturers and merchants of other countries. They declare that this is especially true in our trade with South America and Africa. American consuls state that freight rates on American products by ships of the foreign combination between New York and South Africa are 30 per cent higher than freights on Canadian products from Montreal. Other American consuls testify that it costs more by foreign ships to get a barrel of flour from New York to Rio Janeiro than it does from Austria-Hungary, whose ships are subsidized, and that it is even cheaper to send American flour first to Europe to get it out to South America than it is to send direct. Our export commerce with Brazil, which used to be $15,000,000 annually, fell to between ten and eleven million dollars in 1905, due, so American consuls, merchants and travelers declare, to the European steamship ring that controls freights from New York to Rio Janeiro. Our consul at Singapore reports to Washington that another foreign steamship ring controlling freights from New York

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out verisimilitude, and no good whatever.

Uncle Cannon and Uncle Cannon's constituents know quite well that if our flag is not on every sea, as it was in 1860, it is because American money is earning more in other enterprises than it can in ships.

There are plenty of ships to carry our stuff, and we are getting along marvelously well without subsidized ships.

to the East Indies has lately raised its rates deliberately to favor British manufacturers and merchants, who own and control in part the foreign ships.

American business men who know anything of foreign commerce are familiar with these facts. That is why a large body of them from the middle west left their offices this week to call on President Roosevelt and Speaker Cannon and ask the immediate passage of the shipping bill of the Merchant Marine Commission. These men do not own a dollar in ships and never will. They expect no direct benefit from a subsidy, but they do expect and believe that American ships, amenable to American laws, and operated in the interest of American trade, will give us fair play in the markets of the world, and lead to a great expansion of American commerce.

That is also the view of the National Association of Manufacturers, which in annual session at New York the other day, unanimously indorsed the shipping bill, and sent a committee to Washington to urge its passage.

Does the *Post* profess to say that these American business men do not know as much about American trade as the selfish and jealous foreign steamship combinations, which dread the increase of American ships and the growth of American commerce?

ORDERS FOR NEW SHIPS.

During the past week the American Ship Building Co. has received orders for four new steamers and others are pending. Mr. Henry Steinbrenner, of Cleveland, gave an order for a ship of 10,000 tons capacity to be a duplicate of the vessel ordered a few days previous by Capt. Charles L. Hutchinson. The new steamer will be 545 ft. over all, 525 ft. keel, 55 ft. beam and 31 ft. deep. She will be equipped with triple-expansion engines and Scotch boilers. Mr. John Mitchell, of Cleveland, also placed an order with the ship building company for a duplicate of the steamer James C. Wallace. This boat will therefore be 552 ft. over all, 532 ft. keel, 56 ft. beam and 31 ft. deep and will have triple-expansion engines and Scotch boilers. The fourth order is from Duluth parties for a steamer to be a duplicate of the William G. Pollock, 440 ft. over all, 420 ft. keel, 52 feet beam and 28 ft. deep, to be equipped with triple expansion engines and Scotch boilers. This makes nine bulk freighters and one passenger steamer that the American Ship Building Co. has under order for 1907 delivery.

ORE MOVEMENT.

Notwithstanding the fact that navigation was practically suspended during the first two weeks of May, the vessels succeeded in moving in May 4,304,954 gross tons of ore as against 4,619,431 tons during 1905, a decrease of 314,477 tons. It was expected that shipments would fall off 500,000 tons during the month. The movement to June 1 of the present year was 5,752,340 tons as against 5,814,604 tons for the corresponding period last year, a decrease of only 62,264 tons. These figures reveal the extraordinary capacity of the vessel tonnage of the lakes to cope with the ore movement. There is no doubt whatever that a movement of from 36,000,000 to 38,000,000 tons can be handled comfortably during the present season. The movement of the summer months will undoubtedly be well over 5,000,000 tons per month. In fact, 6,000,000 tons would not put a sensible strain upon the ships. Last year when 34,000,000 tons were handled the movement per month was as follows: April, 1,195,173; May, 4,619,431; June, 4,999,350; July, 5,224,620; August, 5,009,382; September, 4,425,550; October, 4,257,009; November, 3,341,229; December, 401,944.

The following table gives the May movement and the movement to June 1 of the present year with comparative information for the corresponding periods last year.

Port and Dock.	May, 1905.	May, 1906.	To June 1, 1905.	To June 1, 1906.
Escanaba	702,793	680,490	956,092	923,744
Marquette	493,699	319,181	597,978	404,397
Ashland	511,061	497,760	572,758	632,062
Superior	713,265	657,924	903,968	868,187
Duluth	1,103,685	1,140,761	1,367,527	1,524,404
Two Harbors ...	1,094,928	1,008,838	1,416,281	1,399,546
Total	4,619,431	4,304,954	5,814,604	5,752,340
1906 Decrease..		314,477		62,264

COMMERCE OF LAKE SUPERIOR.

Notwithstanding the delay in shipping caused by the longshoremen's strike during the first two weeks of May, lake commerce as measured by the locks at Sault Ste. Marie, has been the heaviest on record up to June 1, exceeding the commerce of 1905 by 776,592 tons. The movement up to June 1, 1906, was 7,852,545 tons as against 7,075,953 tons up to June 1, 1905. This heavy commerce has been handled in the face of obstacles as there has been congestion at both upper and lower ports, and the ore movement was not free at any time during the month. Following is the summary:

MOVEMENT OF PRINCIPAL ITEMS OF FREIGHT TO AND FROM LAKE SUPERIOR.

Items	To June 1, 1906.	To June 1, 1905.	To June 1, 1904.
Coal, anthracite, net tons..	101,954	215,128	43,365
Coal, bituminous, net tons.	1,111,263	843,829	84,365
Iron ore, net tons.	5,176,649	5,139,574	4,625
Wheat, bushels.....	17,335,905	7,503,863	
Flour, barrels.....	1,002,240	701,946	173,977

REPORT OF FREIGHT AND PASSENGER TRAFFIC TO AND FROM LAKE SUPERIOR, FROM OPENING OF NAVIGATION TO JUNE 1 OF EACH YEAR FOR THREE YEARS PAST.

EAST BOUND.

Items	To June 1, 1906.	To June 1, 1905.	To June 1, 1904.
Copper, net tons	23,089	22,005	2,218
Grain, other than wheat, bushels.....	13,072,740	6,451,429	712,587
Building stone, net tons.....	.....	.....	.....
Flour, barrels.....	1,002,240	701,946	173,977
Iron ore, net tons	5,176,649	5,139,574	4,625
Iron, pig, net tons	1,821	8,883	.....
Lumber, M. ft. B. M.....	150,567	152,596	8,105
Silver ore, net tons.....	.....	.....	.....
Wheat, bushels	17,335,905	7,503,863	5,126,791
Unclassified freight, net tons.....	33,325	15,312	1,401
Passengers, number	1,578	1,401	739

WEST BOUND.

Coal, anthracite, net tons.....	101,954	215,128	43,365
Coal, bituminous, net tons.	1,111,263	843,829	84,362
Flour, barrels.....	.....	.....	.....
Grain, bushels	.....	.....	.....
Manufactured iron, net tons.....	68,315	13,333	5,527
Salt, barrels.....	80,853	112,038	37,418
Unclassified freight, net tons...	171,791	119,734	38,506
Passengers, number	2,161	1,388	689

SUMMARY OF TOTAL FREIGHT MOVEMENT IN TONS.

	To June 1, 1906.	To June 1, 1905.	To June 1, 1904.
East Bound freight of all kinds, net tons.	6,387,159	5,857,348	272,606
West Bound freight of all kinds, net tons.....	1,465,386	1,218,605	177,282
Total freight, net tons.....	7,852,545	7,075,953	449,888

Total number of passages to June 1, 1906, was 3,841, and the registered tonnage, 6,642,415.

The new schooner yacht Queen, built at Herreshoff's for J. Rogers Maxwell, was recently launched. The Queen is 126 ft. over all, 92 ft. on the water line, 25 ft. beam and 14 ft. 10 in. draught.

The floating dry dock Dewey, bound for the Philippines, paid $100,000 in dues for the privilege of using the Suez canal. Five days were spent in towing it through the canal.

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BALANCE CYLINDERS.*

BY LUTHER D. LOVEKIN.

The purpose of a balance cylinder is to neutralize the forces set up by a reciprocating body. It should be designed so that these forces meet equal and opposite forces in the balance cylinder instead of transmitting them in the shape of pressure to the crank shaft or whatever other means is used to give the reciprocating motion. A moment's consideration of this proposition will show its great importance and the wide range of its possibilities in the engineering world. It

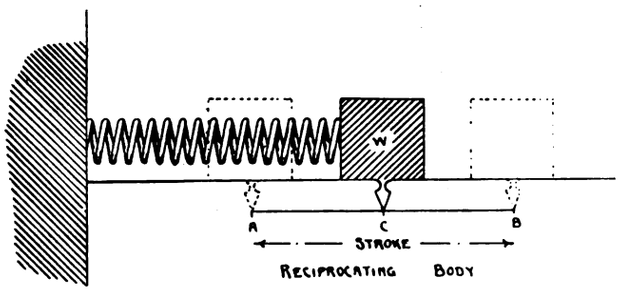

Fig. 1.

is a subject which has hitherto received little or no attention from scientific designers; in fact, the only field to which balance cylinders have been applied thus far is that of valve gears, and this so crudely that the so-called balance cylinders as we have known them are not balance cylinders at all, for they neglect the most important force developed by a reciprocating body. The most notable exception to this is the improved Lovekin-Thom assistant cylinder, the theory of which was set forth in an article before the Society of Naval Architects and Marine Engineers, in New York, November, 1902.

Perhaps the following illustration will give a clear conception of the problem which confronts a true balance cylinder:

In Fig. 1, W is the reciprocating body moving between A and B. It is attached to one end of a spiral spring which is fixed at the other end. The position of the body with the spring at rest would be at C. When in the position A the spring is compressed and at B it is extended. The work ex-

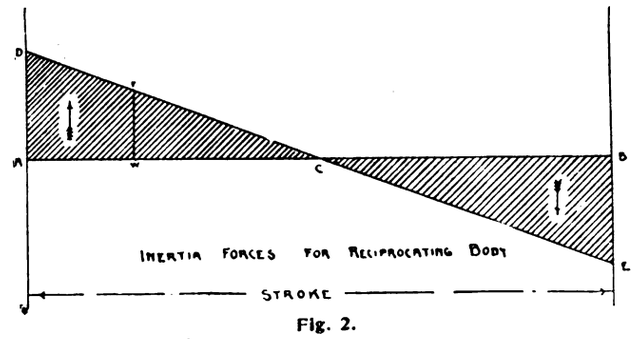

Fig. 2.

pended in distorting the spring from its normal position is returned each time the body comes to the center. Suppose the inertia of the body to be great enough to carry it the rest of its stroke; then, if it were not for friction, the body would continue reciprocating back and forth between A and B without any outside assistance.

This is exactly the function of a true balance cylinder; it should act as a spring or dash pot at each end of the stroke. The energy expended in compression is returned in expansion, so that, theoretically, the reciprocating motion could continue indefinitely without consumption of steam or other outside source of power. This analogy holds good whatever the direction of the reciprocating motion. In the case of the spring, motion in a vertical direction would simply involve a change in adjustment so as to keep the travel between the same points. In a similar way a balance cylinder works just as perfectly on a vertical reciprocating weight by adjusting the bottom pressure so that it exceeds the top pressure by the right amount.

A little consideration of this principle will also bring out the crudeness of the usual type of so-called balance cylinders which relieve gravity only. The force of inertia increases with the square of the revolution, and in modern engines this invariably exceeds the force of gravity. This applies very strongly to high-speed naval engines. For example, at 120 R. P. M. the maximum pressure due to inertia is over twice that due to gravity; hence the folly of counteracting the latter and neglecting the former. It is hard to see why this source of wear and loss of power does not receive more consideration from scientific designers.

There is one type of assistant cylinder on the market

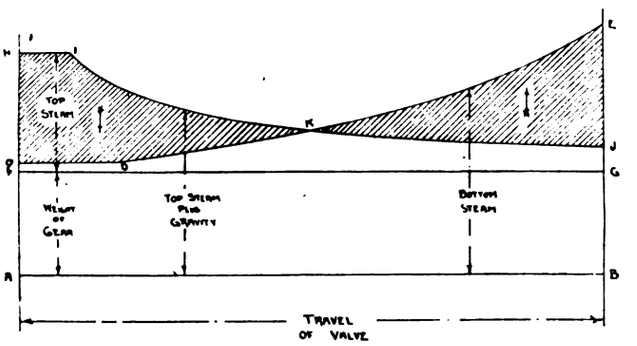

Fig. 3.

which aims in some degree to counteract inertia as well as gravity, but it is very crude and unscientific in its action. It has an exhaust from each end of the cylinder, which, besides wasting steam, is absolutely unnecessary, as shown by the action required.

We will now consider the forces to be overcome in the case of a body which receives its reciprocating motion from a revolving crank. In order to eliminate gravity we will assume first that the motion is in a horizontal plane. We will also neglect friction, for this is a force which cannot be counterbalanced except by the expenditure of work.

See Fig. 2. The body G moves back and forth between A and B so that AB represents the length of its stroke. Let us consider the forces developed during one stroke from A to B. It is stationary at A for an instant and requires a

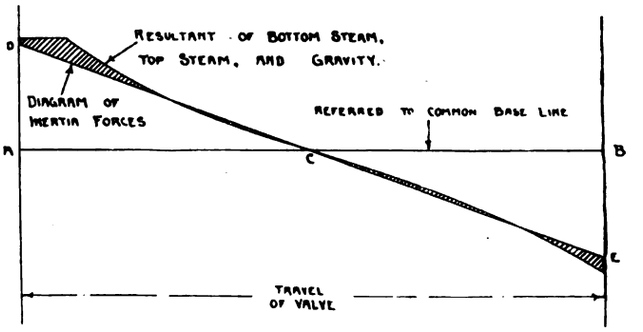

Fig. 4.

force to start it toward B. This force has to overcome the inertia of the body; it is a maximum at A and may be represented by A D. This force continues to act on the body with decreasing intensity till it reaches the center C, where it becomes zero. At this point the body has attained its maximum velocity and must be retarded toward B. To accomplish this a retarding force is required exactly equal in intensity but opposite in direction to the accelerating force required up to the point C. This retarding force also reaches its maximum at the end of the stroke, where the body is

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brought to rest. We represent this force by B E below the line A B; thus the triangles A D C and B E C represent the diagram of forces necessary to overcome the inertia of the body during its progress from A to B. The same diagram holds for the return from B to A, except that the former ac-

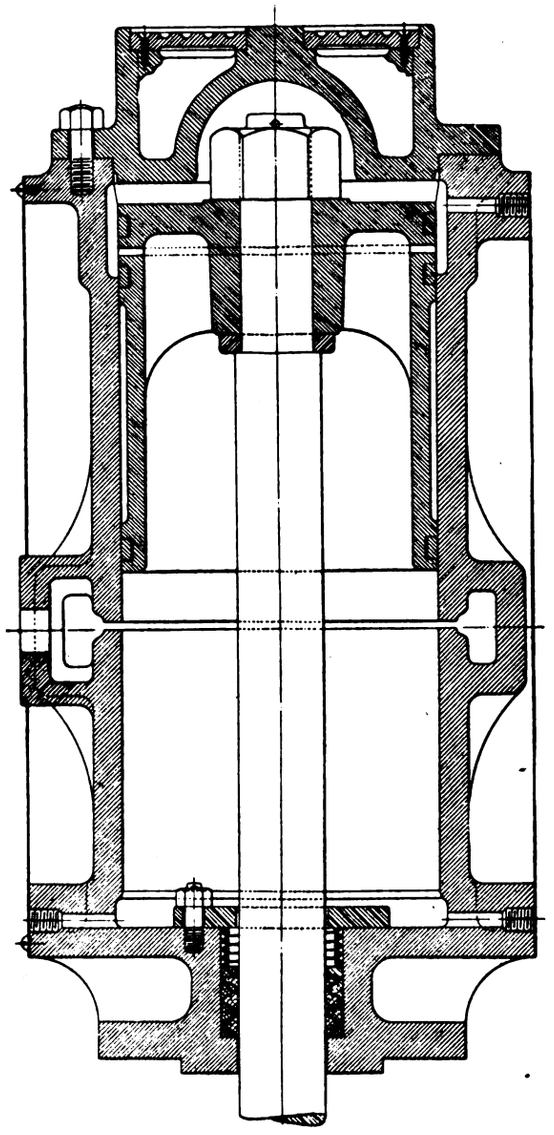

FIG. 5.—THE LOVEKIN-THOM IMPROVED ASSISTANT CYLINDER AS FITTED ON STEAMSHIP MANCHURIA.

celerating forces now become retarding forces and vice versa. Their direction of action remains unchanged and may be indicated by the arrows shown in Fig. 2. Thus at the position W when traveling toward B the accelerating force is represented by W F. When returning toward A the retarding force at the point W is also represented by W F and acts in the same direction.

For purposes of calculation in actual design the diagram of these inertia forces is plotted from the formula developed in the article mentioned. This is the formula used in all such calculation of inertia forces where the angularity of the connecting rod is not considerable. The maximum force (represented in Fig. 2 by A D or B E)= .0003408rN²W, where r = crank arm, in feet,

W = weight of reciprocating body, in pounds,

N = revolutions per minute.

When the reciprocating motion is produced from a crank with relatively short connecting rod the motion of the body is influenced to a great extent by the angularity of the latter. This requires a modified diagram to express the force at various points of the stroke. The equation for the force at any point is represented by the equation

$$F = .0003408rN^2W\left(\cos\theta + \frac{\cos 2\theta}{n}\right)$$

where o is the angle made by the crank with the line of travel, n = ratio of connecting rod to crank, R, N and W as before. By this formula the line representing the forces throughout the stroke becomes a curve instead of a straight line, as shown in Fig. 2.

In the present discussion we will consider a balance cylinder design for a valve gear, which is the common application of the device. And in this case the ratio of the eccentric rod to the eccentricity is so great that we may neglect the angularity of the rod and work from the diagram first proposed. That is a straight line, as in Fig. 2, where A D is determined by the formula F = .0003408rN²W.

We now have the forces presented in such form that a cylinder may be designed on scientific principles to balance the forces expected, and without such an analysis a systematic consideration of the forces developed is impossible.

The valve gear under consideration is vertical, which in-

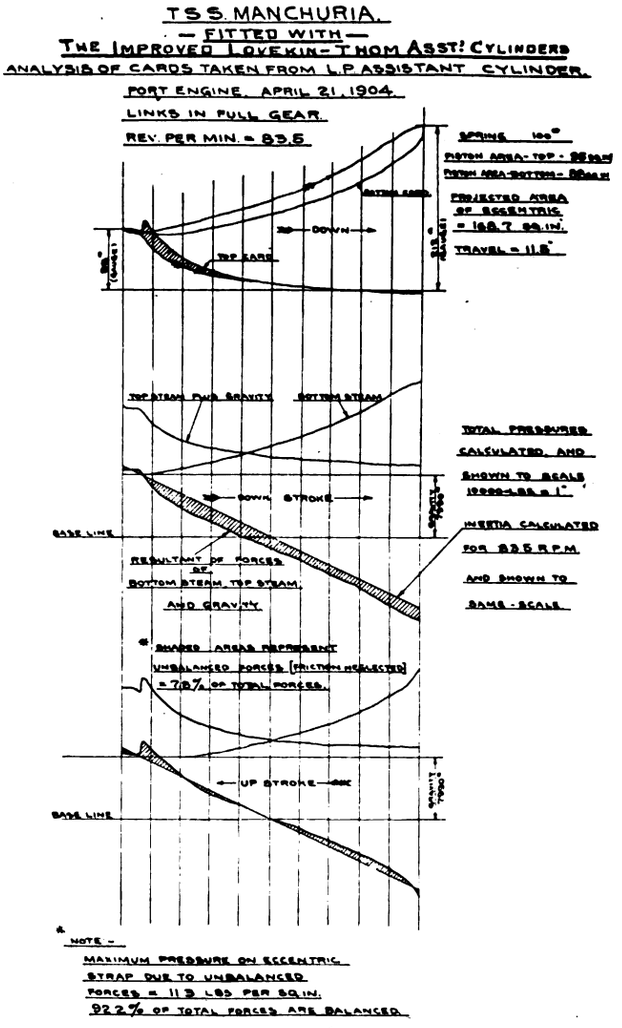
T.S.S. MANCHURIA.
— FITTED WITH —
THE IMPROVED LOVEKIN-THOM ASST? CYLINDERS
ANALYSIS OF CARDS TAKEN FROM L.P. ASSISTANT CYLINDER.
PORT ENGINE. APRIL 21. 1904.
LINKS IN FULL GEAR.
REV. PER MIN. = 89.5
SPRING 100
PROJECTED AREA OF ECCENTRIC = 188.7 SQ. IN.
TRAVEL = 11.8"
DOWN
TOP EXHST.
TOP STEAM
BOTTOM STEAM
DOWN STROKE
BASE LINE
RESULTANT OF FORCES OF BOTTOM STEAM, TOP STEAM, AND GRAVITY
TOTAL PRESSURES CALCULATED AND SHOWN TO SCALE
INERTIA CALCULATED FOR 89.5 R.P.M. AND SHOWN TO SAME SCALE
SHADED AREAS REPRESENT UNBALANCED FORCES (FRICTION NEGLECTED) = 7.8% OF TOTAL FORCES.
UP STROKE
BASE LINE
NOTE —
MAXIMUM PRESSURE ON ECCENTRIC STRAP DUE TO UNBALANCED FORCES = 113 LBS PER SQ. IN.
92.2% OF TOTAL FORCES ARE BALANCED.

FIG. 6.

troduces the force of gravity into our problem, but this does not affect the inertia forces to be overcome, for they remain the same no matter what the direction of the reciprocating motion. We allow for the force of gravity simply by taking it as a component part of the downward forces considered in the balance cylinder. The downward force exerted within the cylinder itself is the total pressure of the steam on top of the piston. This we have under control, though of course

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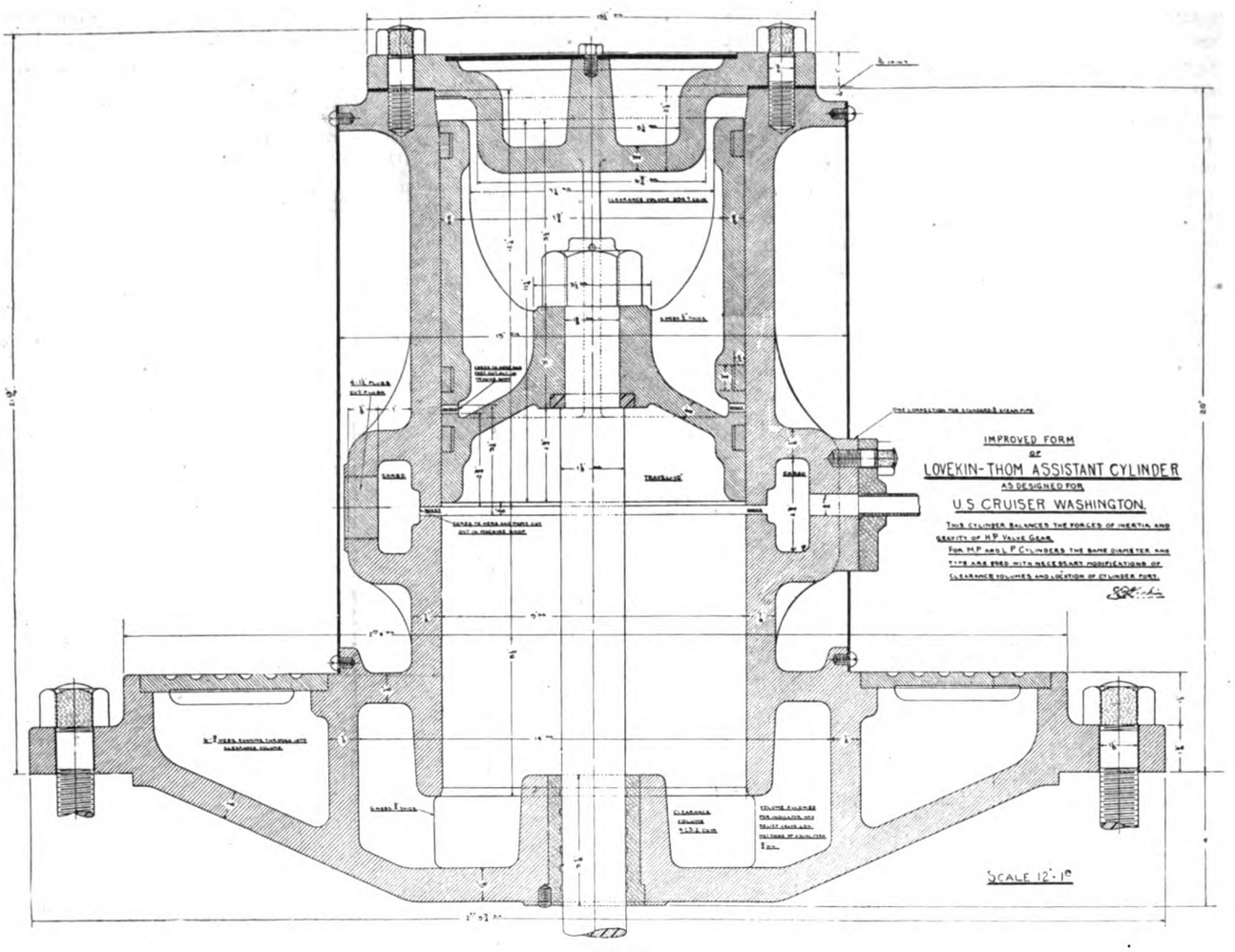

FIG. 7.

the other component, that of gravity, is fixed and constant. The total downward force therefore consists of the weight of the gear plus the total pressure of steam on top of the piston. The upward force consists solely of the steam pressure under the piston.

We now have to arrange the forces at our disposal in such shape that they will neutralize as nearly as possible the inertia forces previously ascertained. This is done by means of a diagram, where the forces are plotted to the same scale as the inertia in Fig. 2. We start with the base line A B, Fig. 3, in which the length A B represents the length of the stroke or travel of valve, A being the top position and B the bottom position. On this base line we plot the total upward steam force, i. e., the net area of piston multiplied by the pressure of the steam. We take the steam supply at such a pressure that the total force under the piston is represented by the line A C. We carry this pressure from C to D on the down stroke.

At D the supply is cut off and compression begins as the piston continues its downward stroke. The pressure now rises in accordance with the well known law, P V = constant. The volume is calculated so that the desired pressure is reached at the end of the stroke, and the total upward force there is represented by the line B E. On the return stroke the pressure at E is expanded down the line E D in the same manner as it was compressed. Thus the line C D E represents the theoretical indicator-card diagram for the bottom of the balance cylinder. In actual practice it is found that the expansion on the up stroke will not return exactly along the compression line of the down stroke. It falls below to an extent that depends upon the leakage and condensation in the cylinder.

We turn now to the downward forces which oppose those represented by the line C D E. First, upon the same base line we construct the line F G at a distance above A B corresponding to the weight of the reciprocating parts. This is the fixed and constant component of the total downward force. The other component is the total steam pressure on the top of the piston. We will therefore plot this top steam pressure above the line F G, so that the total downward forces may be represented by the distance of the top steam line above the base line A B.

The top steam is received at the same pressure as the bottom steam, but the total pressure of the top steam will be slightly greater than that of the bottom, owing to deduction for rod area in the latter. It is represented by the line H F. This pressure continues along the down stroke to the point I, where cut off occurs. From the point I the volume in the upper part of the cylinder increases with the travel of the piston, and as it is no longer connected with the steam supply its pressure decreases. This expansion takes place along the line I J to the point J at the bottom of the stroke. The process is reversed during the up stroke and the expanded steam at J is again compressed to the pressure I along the same line. Thus the line H I J represents a theoretical indicator diagram for the top of the cylinder. In practice the compression from J to I does not follow exactly the same line, but runs a little higher, due to leakage and re-evaporation.

We now have the total upward and downward forces re-

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ferred to the same base line A B, and represented by the lines C D E and H I J, respectively. From the top of the stroke to the intersection K the downward forces are in excess of the upward, and their difference is represented by the ordinates of the diagram H K C. From K to the bottom of the stroke the upward forces are greater, and the difference represented by the diagram E K J. These differences, as shown in the cross-hatched areas, Fig. 3, represent the net resultant of the upward and downward forces of steam and gravity. Their directions of action are indicated by the arrows and do not

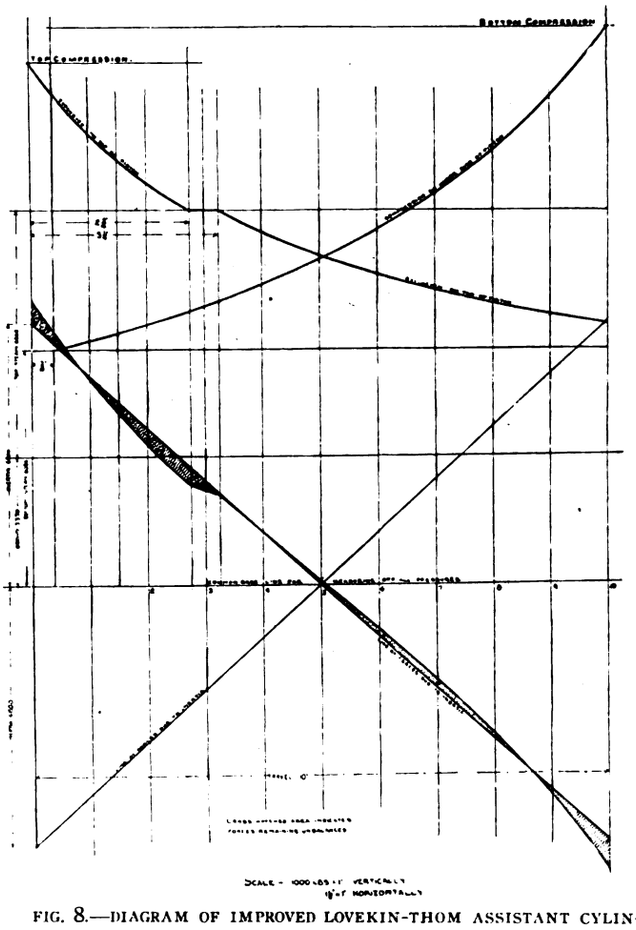

FIG. 8.—DIAGRAM OF IMPROVED LOVEKIN-THOM ASSISTANT CYLINDER AS DESIGNED FOR U. S. ARMORED CRUISER WASHINGTON, HIGH-PRESSURE VALVE GEAR.

Top clearance = 4.633 linear inches = 294.7 cubic inches.
Bottom clearance = 7.053 linear inches = 429.2 cubic inches.
Diameter of cylinder = 9 inches, diameter of rod = 1⅞ inches.
Pressure 85 pounds per gauge = 100 pounds absolute.

change, hence these are the forces available to overcome the inertia previously determined.

We may now take the inertia diagram in Fig. 2 and apply to it the resultants obtained in Fig. 3. This is done in Fig. 4. It will be noted that the forces are opposite in direction and vary so nearly in the same manner that they neutralize very well. Thus the cross-hatched area in Fig. 4 represents the total unbalanced pressure on the eccentric strap during the stroke.

It will be noted that no exhaust or other consumption of steam is called for in this design. The cylinder acts as a cushion or spring at each end of the stroke, and the steam supply is simply to furnish an elastic medium and make up whatever losses occur due to leakage and condensation.

This theory in the design of balance cylinders has been applied and is operating with great success in the ships built by the New York Ship Building Co. The design has now been perfected so that the actual results as taken from indicator cards approach very nearly the theoretical conditions.

The most notable example of this is the low-pressure balance cylinders of the S. S. Manchuria, recently completed and now on her journey "around the Horn" to San Francisco. Fig. 5 shows the design of this balance cylinder for a theoretical diagram, such as shown in Fig. 4. The steam is taken from the first I. P. receiver, as it was found that the low pressure carried in the L. P. valve chest would entail a cylinder too large in diameter. By this means the diameter of the cylinder was cut down to one-half and the weight to one-third of what would be needed for a balance cylinder operating on the L. P. receiver pressure. The reciprocating parts of this L. P. valve gear weigh nearly 8,000 pounds. The diameter of the balance cylinder is 11 inches and travel of valve 11½ inches. The valve is flat, double ported, slide, with relief frame on back. There is necessarily some friction in this type of valve, but gravity and inertia are the most important elements.

Fig. 6 shows indicator cards taken on trial trip April 21, 1904. Separate diagrams are laid out for up and down strokes. This is necessary, owing to the fact mentioned before, that the steam pressures in practice do not follow identical lines in the process of compression and expansion. But this is so slight that the effect on the diagram is not serious. A study of these cards and the diagrams plotted from them will show how completely the forces of inertia and gravity are counterbalanced; 92½ per cent is the proportion of the total forces that are neutralized by the action of this balance cylinder. The maximum pressure per square inch on the projected area of the eccentric strap amounts to just 11.3 pounds. Had this gear been fitted with an ordinary balance cylinder, and gravity balanced exactly, there would still have remained a pressure of about 54 pounds per square inch due to inertia.

These diagrams being plotted from actual conditions show beyond question the utility and efficiency of this type of balance cylinder. The effect noticed on other ships running with this device is that there is no heating due to friction and no wearing down of the gear, hence the valve setting remains constant. One record at hand is that of the S. S. Texan, which ran over 100,000 miles without any necessity for lining up the valve gear.

Another point of advantage to be noted in this design of cylinder is that the pressure of the steam automatically adjusts itself to correspond with the revolutions per minute. It is a matter of general observation that receiver pressures vary nearly as the square of the revolutions, hence the suitability of receiver pressures for counterbalancing inertia at varying speeds. Cards taken and analyzed show a pressure on the eccentric strap which is nearly uniform throughout the stroke for all speeds. The balance is most perfect at the designed speed, but in no case does the variation approach that of an ordinary balance cylinder, even under the best condition of the latter. The ordinary balance cylinder does not counteract gravity except at one particular pressure in the receiver, and this lack of balance increases directly with the variation from that pressure.

These balance cylinders are to be applied to the armored cruiser Washington and the battleship Kansas, now building for the U. S. navy. In these designs some interesting problems were encountered, as the inertia formed such a large proportion of the forces to be balanced. This necessitated a change in the form of the piston used, to produce compression on top as well as on the bottom. The design adopted is shown in Fig. 7. The theoretical diagram from this cylinder is shown in Fig. 8. It will be seen from this diagram how perfectly the forces neutralize; in fact, the fulfilment of these theoretical conditions would bring about a balance so perfect that the heavy gears might be run by a thread. While the actual results cannot quite equal the theoretical diagrams shown, they will approach very closely, as proved in the case of the S. S. Manchuria.

This means a material reduction in power lost due to

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friction, with consequent saving of lubrication and fuel as well as labor in repairs and adjustment. On the cruiser Washington the reciprocating parts of the L. P. valve gears weigh over 5,000 pounds. At 120 revolutions per minute the inertia force reaches a maximum of 10,500 pounds at each end of the stroke. This shows how much more important is the latter element; hence it should really receive first attention when considering a balance cylinder.

A little consideration of the action of a scientific balance cylinder will suggest many uses for which it may be designed. It has been shown both theoretically and practically that the forces set up in a reciprocating body may be neutralized so far as pressure on the crank is concerned. It costs nothing to operate. Why, then, should it not be used on a larger scale to do away with the wear and friction that such pressure entails? It is by no means restricted to vertical valve gears aboard ship. There are thousands of reciprocating weights wearing away at their driving gears in all branches of the engineering world. Consider the high-speed engine valve gears alone. On some the inertia runs into large figures, and this explains the continued adjustment necessary to take up wear, not to mention the oil used to keep them cool. Both horizontal and vertical engines are subject to the same inertia pressures, which might just as well be borne by a properly designed balance cylinder. Other lines of engineering suggest other reciprocating weights which are hammering away at their bearings. Why not put a balance cylinder wherever a body reciprocates fast enough for the inertia to equal its weight? Steam is not necessarily the elastic body with which it may be operated. In fact, air is superior in many respects. Even at atmospheric pressure it may be used in suitably designed cylinders. There is undoubtedly a large field for the development of this principle in other lines besides that of marine engineering.

In conclusion, the following summary is given of the advantages of properly designed "balance cylinders" for valve gears alone:

1. Increased I. H. P. of main engines, or a corresponding reduction in coal, or other fuel, due to decreased friction of valve gear.
2. Saving in oil, due to decreased friction of valve gear.
3. Reduction in weight and first cost of cylinder when used on low-pressure valve gears to replace old style balance cylinder.
4. Valve gear can be 25 per cent lighter and still retain the safety of the heavier gears as ordinarily used.
5. All strains due to inertia and weight are removed from the crank shaft; thus smoother running of the engine is obtained.
6. Repair bills reduced to a minimum, the valve gear being free from pressure, and the wear and tear on all parts being insignificant.
7. Troublesome valve gears can be positively corrected by the application of such cylinders.

EXPERIMENTAL TANK AT ANN ARBOR.

HERBERT C. SADLER D. SC. PROFESSOR OF MARINE ENGINEERING.

As the experimental tank and apparatus connected therewith is now completed, a short account of the method of preparation and testing of ship models may be of interest at this time.

In the first place it may be pertinent to describe in a general way the object of the tank. The shape or lines of a vessel, together with the estimate of the horsepower necessary to drive her any given speed, is the most interesting and at the same time most difficult part of the naval architect's work. Fortunately or unfortunately the nature of the conditions to be fulfilled are rarely the same for any two ships, so that although former experience, properly and scientifically applied, may be of great value in solving any new problem in ship propulsion that may arise, it seldom happens that a new design is the exact counterpart of a former one. It is, therefore, difficult to say beforehand what the effect of modifications of a vessel's form will be, and even more difficult to say which is the best form to fulfill any given set of conditions.

The primary object of the tank is to perform experiments upon various forms of ships and to determine the resistance to motion of these forms at all speeds. In general the line of work that will be followed will be of a systematic character, that is to say, models of various forms will be tried and the effect upon the resistance of modification of these forms, such as variation of the ratio of length to beam or draught, determined. Numerous other experiments such as the effect of bilge keels upon the rolling and speed of vessels will also receive attention.

The tank itself is 300 ft. long, 22 ft. wide, and 10 ft. deep, and forms the basement to the east wing of the New Engineering building. This length is the least that can be used in order to allow time for starting, obtaining uniform speed and stopping. The breadth and depth are necessary so that the effect of the sides and bottom will not have any material influence upon the resistance of the model. Spanning the tank is a traveling truck which runs on rails on either side of the tank. This truck, shown in Plate 2, is driven by a 25-H. P. motor whose speed can be so regulated as to give speeds to the truck varying from about ten feet per minute up to eight hundred feet per minute. It is essential that the speed of the truck should be uniform at any speed between these limits, so that the resistance of the model may be determined accurately at any speed. The models are run at a series of different speeds and a curve of resistance in terms of speed obtained. In order that the speed may be uniform and not affected by changes of load in the power house, a special motor generator set has been installed, and owing to exigencies of space and also for convenience, has been placed upon the truck. The current from the power house is taken to this set by trolleys and converted as required. The connections are such that if any fluctuation takes place upon the line, this is compensated for in the installation and the speed of the driving motor remains unaffected. The speed is regulated by a controller with five main stops, and between each stop an auxiliary rheostat with fifty stops may be thrown in, so that between the limits of speed given above, two hundred and fifty different speeds may be obtained. The driving motor is also fitted with a high and low speed gear. The switchboard and connections are also mounted on the truck.

On the forward end of the truck is the dynamometer through which the models are towed. This consists essentially of a vertical bar mounted on emery supports, that is to say, instead of the usual knife edge a thin piece of spring steel is used, with about one-sixteenth of an inch between the supports. This gives a rigid but flexible and practically frictionless bearing. Parallel rods are introduced so that both the pull upon the spring and model are in a horizontal direction. The model is attached to the lower end of the dynamometer and its resistance taken up by the spring as shown in Plate 3. The amount of extension of the spring is registered upon a revolving drum which is driven from the main shaft of the truck. Upon this drum are two other pens, one of which is connected to a clock and registers every half second, the other is connected with contacts along

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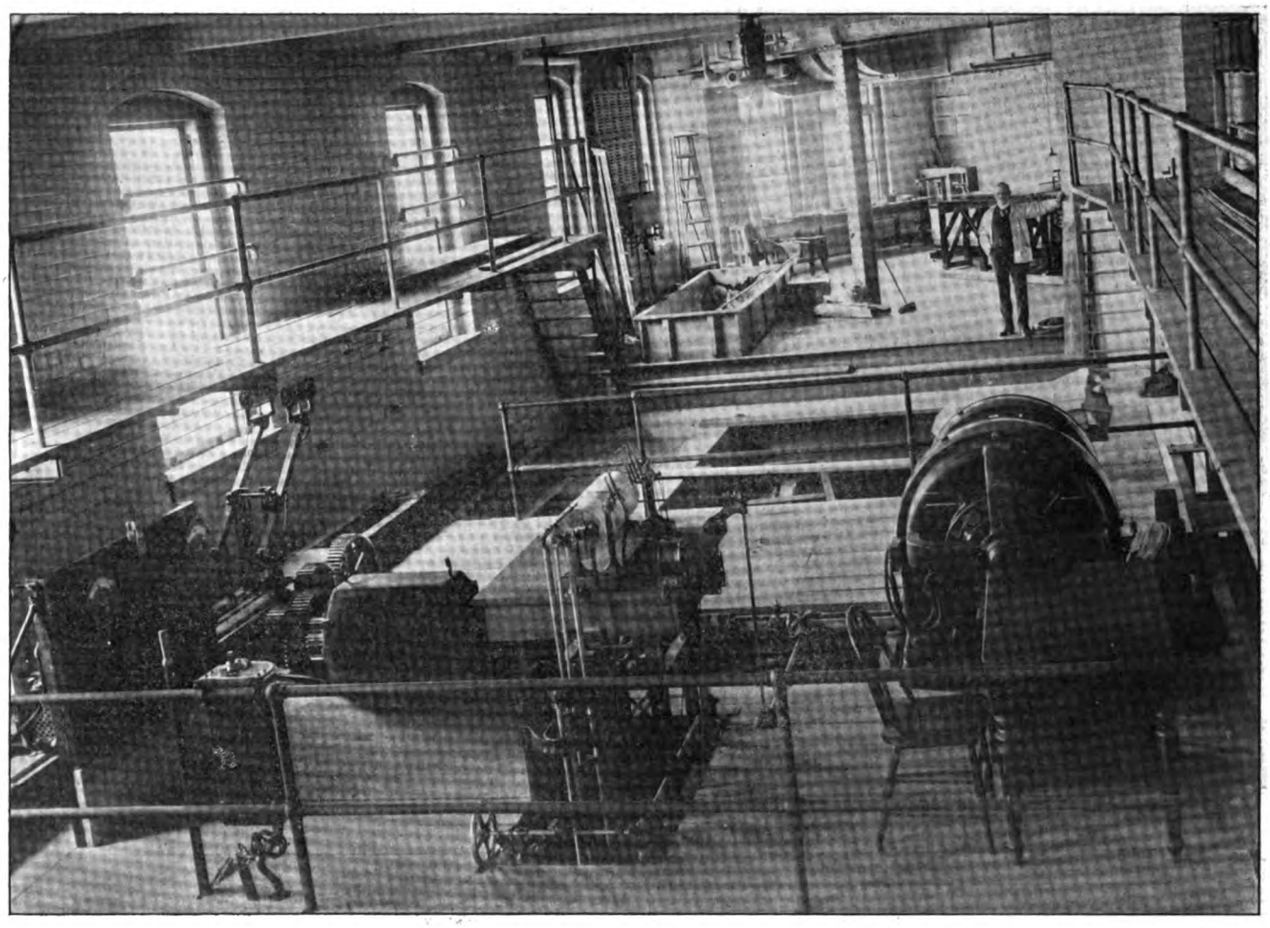

PLATE I.—TRAVELING TRUCK AND DYNAMOMETER.

the side of the tank and registers every ten feet. Thus the time and distance and hence speed are determined. Two other pens register the amount that the model rises or falls at the bow or stern, when moving at different speeds. While not at present installed, a camera will also be arranged so that a photograph of the wave formation may be obtained. The above are the principal observations that are taken in connection with the truck and dynamometer.

The preparation of the models themselves will now be considered. The substance of which the models are made is paraffine wax with a mixture of about four per cent beeswax. This material is the same as that used in most laboratories of this kind, and was chosen for the following reasons: It is very easy to handle, that is to say, it may be melted at a low temperature and cast without difficulty; it is also easily cut, planed or scraped; it enables us to have a uniform surface for all models, and when a model is not required for further experimenting it may be broken up and used for another of a different type.

Before casting a model a mold is first prepared. This mold is made in ordinary modeling clay. Sections of the vessel at different points in its length are first cut out of wood, about one-quarter of an inch larger than the actual size required. These are placed in the bed and the clay molded and faired in until it conforms to the proper shape. As the models have to be cast hollow, a core is next made. The forms as above are cut out so as to allow a thickness of paraffine wax of about one and one-quarter inches. These forms are then connected together by thin wooden strips and covered with canvas, so that the core forms as it were a canvas canoe which is suspended inside the clay mold. The paraffine wax is then melted in a tank provided with a steam coil and the mold poured. While cooling considerable contraction occurs so that small quantities of melted wax must be added continually. While the wax is being poured, water is introduced into the inside of the core in order to overcome its tendency to float and also to aid in cooling.

When cooled the core is withdrawn and the model floated from its bed by introducing water between the walls of the mold and the model. The model is now in its rough state and ready to be cut to the correct form. It is next placed in the cutting machine (Plates 3 and 4). This machine consists primarily of two tables, on one of which is placed the model and on the other the drawing of the lines which it is desired to reproduce. These two tables move together and are driven by a motor, the motion of the driving table is, however, usually about one-half as fast as that of the model table; but this ratio can be varied by introducing change gears. The object of this is so that the drawings do not have to be made unnecessarily large. In the middle of the machine is a cross piece upon which are two traveling heads which move together inwards or outwards and are operated by a right and left-handed screw by means of the handle shown on the right hand side immediately over the drawing. These heads carry two vertical hollow spindles which have a screw thread cut on the outside. By means of a worm gear these may be raised or lowered to any desired extent, the amount of the vertical movement being measured by a scale and vernier upon one of them. Inside each spindle is a shaft which is driven by a vertical motor on the top, and to the bottom of which is attached a two-bladed cutter. As the in and out motion of the cutters must correspond with the breadth upon the drawing at various points, the motion of the cutters is transferred to the drawing by means of a pantograph. One end of the pantograph is attached to one of the cutters and the other movable or center part to

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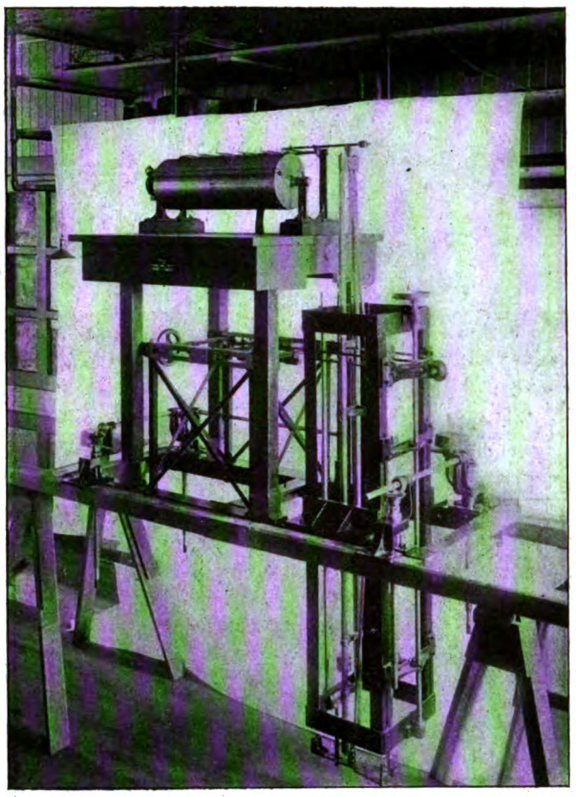

PLATE 2.—DYNAMOMETER.

a bar which is carried over to the drawing and on the end of which is a pointer. If for example the drawing is one-half the size of the model, the arms of the pantograph are set in this ratio. When therefore the screw which operates the heads carrying the cutters is revolved, the cutters move in or out a certain amount, and the pointer on the drawing one-half this amount. As, however, the points of the cutters describe circles, the pointer is also a circle but of one-half the radius of the cutter circle. (In cases where a different ratio of length to breadth from that as shown in the drawing, is being cut, the pointer is an ellipse). In Plate 1 it will be noticed that an adjusting lever is attached to the fixed arm of the pantograph, the reason for which is as follows: It sometimes happens that the drawing paper and hence the center line of the drawing may become warped. Under these circumstances the cutters would not be cutting the actual breadth from the center line, but from some imaginary straight line. The end of this lever is therefore attached to a frame which carries a roller, which bears against a batten which is placed upon the center line of the drawing, no matter what form this has taken. If the center line is slightly curved the roller follows this curve and moves the fixed end of the pantograph a corresponding amount and therefore compensates for this error.

From one drawing it is possible to cut any number of models of the same form but varying in ratio of beam or draught to length. If a broader or narrower model is desired all that has to be done is to alter the fulcrum of the pantograph and the relative motions of the cutter and pointer on the drawing are altered accordingly. If it is desired to change the ratio of draught to length, the amount

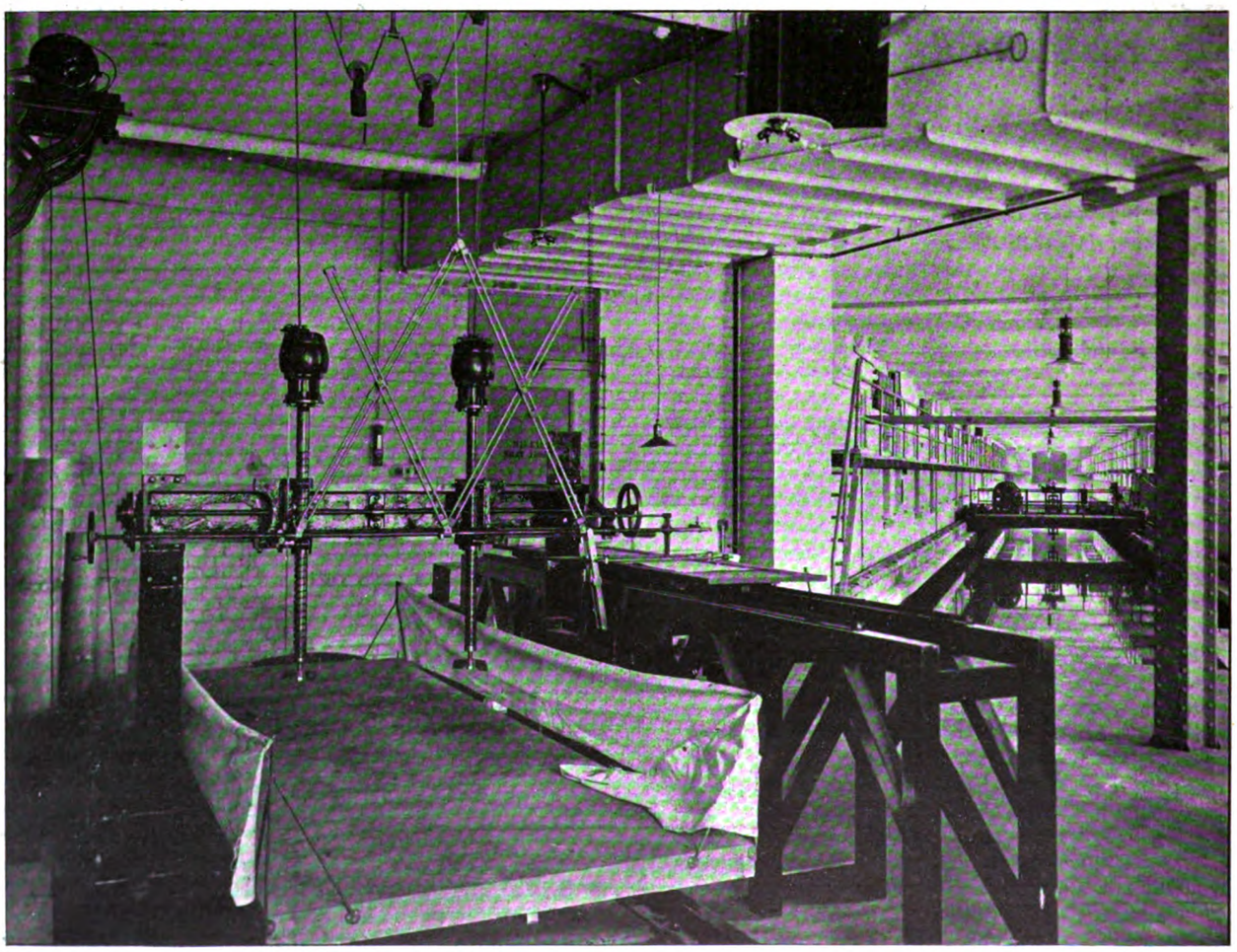

PLATE 3.—MODEL CUTTING MACHINE AND TANK.

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by which the vertical motion of the cutter is changed for each water line may be correspondingly increased or decreased.

The method of operation is as follows: The model is placed upside down upon its table carefully centered and clamped down, the drawing is also placed upon its table and the center line adjusted. The cutters are now run up to the bottom of the model and moved in so that they nearly touch. They are then put into motion, as is also the table, and the base line or top of keel cut from one end to the other. The cutters are now lowered to a depth corresponding to the first water line as shown on the drawing. The cutting is usually started from amidships and worked both ways toward the ends. The operator now runs in the cutter until the pointer is exactly upon the line required and starts the two tables moving. By operating the handle on the right and left handed screw, the cutters are gradually brought together and their motion transferred to the pointer. He must so regulate this motion that the pointer remains tangent to the line he desires to follow, while the drawing moves along. In this way the cutters are made to follow exactly any desired line. When one line has been cut they are lowered to the next and so on until all the lines have been cut. When this part of the work is finished, the model has the appearance as shown in Plate 4, that is to say, a series of longitudinal grooves have been cut, which represent the correct shape of the various waterlines. It is now taken to the finishing table and the superfluous material between the grooves removed by a chisel, plane, or spokeshave until the grooves have almost disappeared. It is finally finished with a scraper and when the grooves have just disappeared and the surface is fair, it receives a final burnishing. The position of the desired load or any other water line is now marked upon it at different points and check measurements are taken to see if the model is correct to the drawings. It is then carefully weighed and placed in the tank. The amount of ballast, which consists of shot bags, necessary to bring the model down to the desired load line, is also calculated and weighed out. This is now put into the model and moved until the latter floats upright and in her correct trim. This is the final check that the model receives, as it should float at its correct waterline when the calculated amount of ballast has been added.

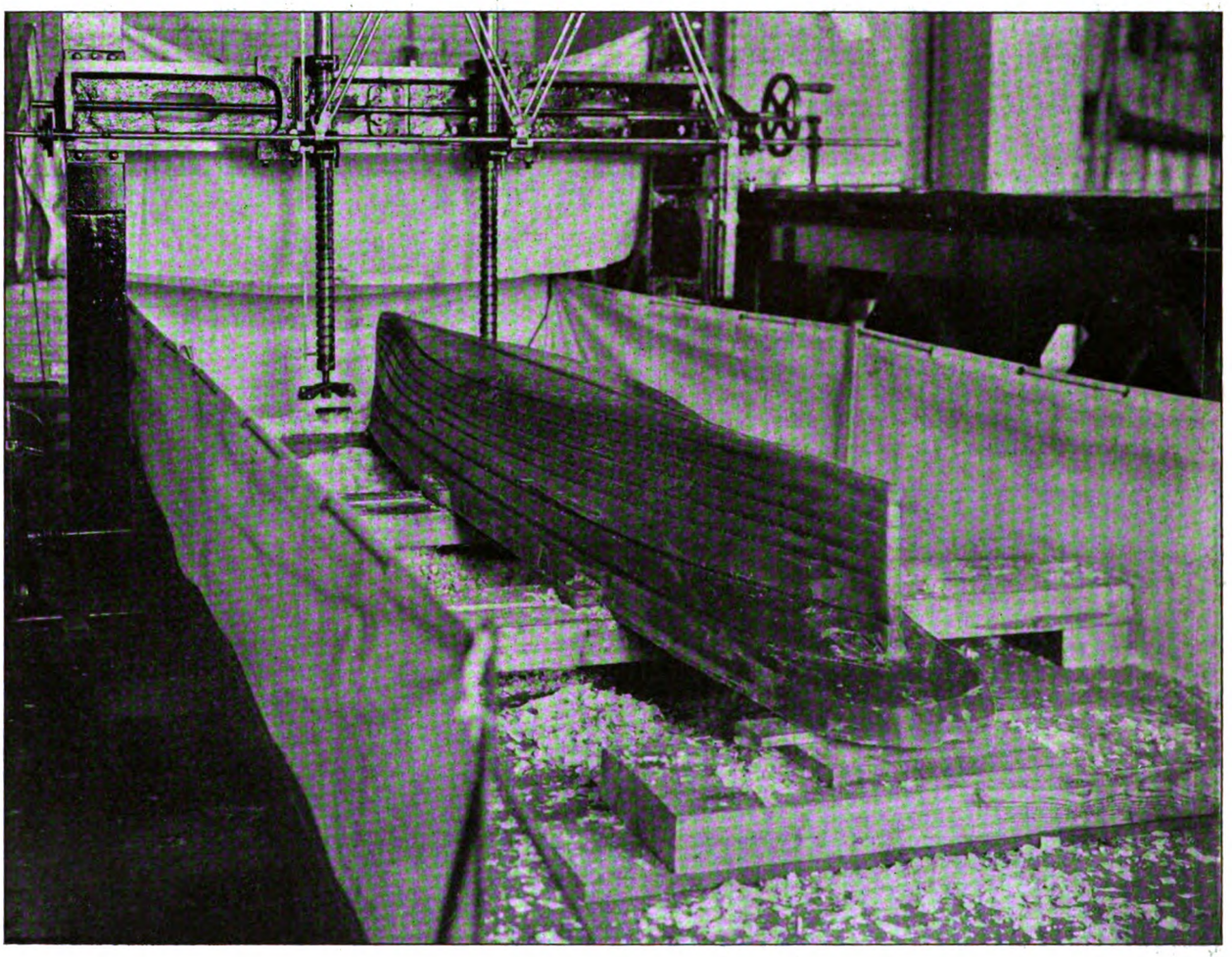

PLATE 4.—MODEL CUTTING MACHINE.

The attachment for the towing and steering rods are now made and the model connected up to the dynamometer.

The models used are from ten to twelve feet long, and may represent a vessel of any size. In order to predict the resistance of a full sized ship from that of a model, Froude's "law of comparison" is used. The total resistance of a vessel consists of two parts, surface friction and wave making resistance. The frictional resistance may be calculated for any kind of surface whether paraffine, paint, copper, etc., from the knowledge of the corresponding coefficients of friction of these surfaces. If this be subtracted from the total, the remainder will be the wave making resistance. According to Froude's law, this resistance varies as the cube of the lineal dimensions at corresponding speeds, i. e., at speeds varying as the square root of the lineal dimensions. For example, if a model were one forty-ninth the full size and were towed at a speed of three knots per hour, the cor-

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responding speed of the full sized ship would be $7 \times 3 = 21$ knots. If at this speed of three knots the wave making resistance of the model were, say, three pounds, the wave making resistance of the full sized ship would be $3 \times (49)^3 = 352{,}947$ pounds (at 21 knots). To this must be added the frictional resistance, calculated as explained above in order to obtain the total resistance of the vessel.

It is therefore possible to experiment with models at fairly low speeds and yet obtain results which correspond with high speeds in the full sized ship.

The subject of resistance of ship's forms is one which requires a large amount of investigation, and it is expected that the work done at the university will help towards the solution of many problems and prove a benefit to the profession of naval architects as a whole.

One of the first vessels to be tested in the experimental tank was the car ferry Ashtabula, recently launched by the Great Lakes Engineering Works. The vessel is 338 ft. long, 56 ft. beam and draws from 14 ft. to 15 ft.

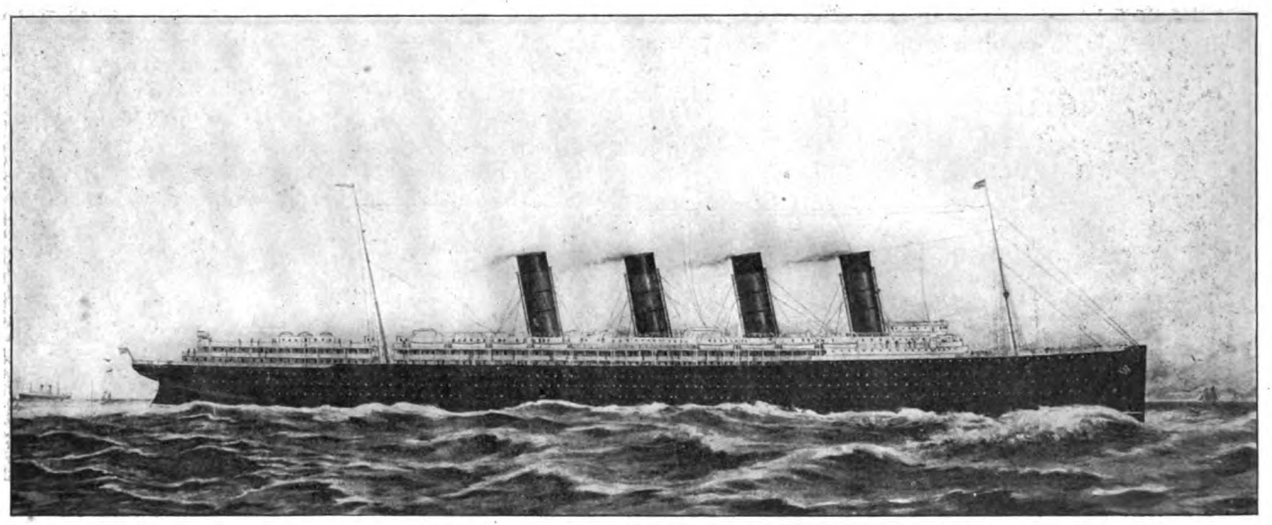
The model was run at different draughts and trims, and a series of experiments are now under way to determine the effect upon the resistance of the bossing around the twin shafts. Although the series is not quite complete, it may be of interest to note that the trials of the model confirm the horsepower of the boat as estimated in the first place.

Models of the W. G. Mather and other lake freighter types are also being tried and the effect of the modification of shape upon the resistance of the vessel determined. Later on it is proposed to try the effect of shallow water upon the resistance of various ships' forms.

CUNARDER LUSITANIA LAUNCHED.

Today, (June 7) Mary, Lady Inverclyde, widow of the late Lord Inverclyde, will launch and name the 25-knot turbine quadruple-screw Cunarder Lusitania. There is a special suitability in this arrangement, for the inception of the movement which culminated in the ordering of the Lusitania, and her sister ship Mauritania was due to the late Lord Inverclyde, and his ability and courage were important factors in the settlement of many of the details of design of turbines. In the negotiations that took place between the late Lord Inverclyde and the British government shortly after the formation of the International Mercantile Marine Co., the superb administrative qualities and statesmanlike outlook of the late Cunard chairman were first brought into wide public notice. Although Baron Inverclyde has not lived to see the agreement fulfilled that was entered into between the British government and the Cunard company, he it was who first made it possible. The 1903 agreement bound the British government to give the Cunard company a payment of £150,000 a year, and a government loan up to £2,000,000 at 2¾ per cent interest for the purpose of building these two ships, and incidentally to maintain the "all British" character of the Cunard company. The two firms to whom the contracts to build these sister liners were given are the Lusitania to Messrs. John Brown & Co., of Clydebank, and the Mauritania to Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend on Tyne. The building of the latter vessel is also in an advanced state, and her launching will take place sometime during September of this year.

As both these vessels are meant to regain the record honors of the North Atlantic, it may be of interest to give a comparison with the best German liner. The Kaiser Willhelm II at present holds the fastest speed record for the Atlantic, 23½ knots. The two new Cunard vessels are each 790 ft. in length over all, 88 ft. broad,



THE CUNARD QUADRUPLE SCREW TURBINE 25-KNOT EXPRESS STEAMER LUSITANIA.

and 60 ft. 6 in. depth molded. They will each have a displacement of about 40,000 tons. It will be seen therefore that in the new Cunarders it was found necessary to exceed the dimensions of the Kaiser Wilhelm II by 84 ft. in length, 16 ft. in beam, and 8 ft. in depth, while the displacement has been increased by 14,000 tons. The 38,000 I. H. P. of the German vessel will be exceeded by about 60 per cent to ensure an increased speed of at least one knot an hour or at most 1½ knots. Into the construction of the two new British flyers there will enter about 60,000 tons of material, 30,000 tons in each ship, which will give an idea of the magnitude of the task undertaken by each of the ship building firms responsible for their construction. To carry the comparison further with the largest British ship yet built is interesting reading. The White Star liner Baltic has this distinction, yet the two new Cunarders will be 61 ft. longer than the Baltic, 13 ft. broader, and 11 ft. more of molded depth,

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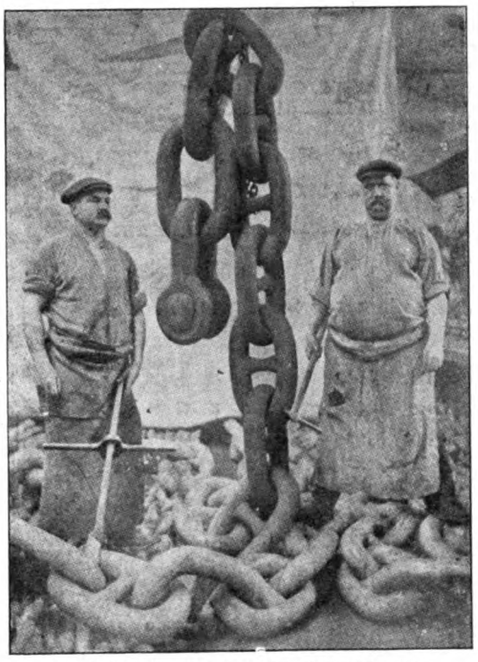
yet in point of deadweight they will have only 3,000 tons more displacement, showing how fine their under water lines must be. The Baltic has maintained a speed of 16.25 knots an hour crossing the ocean, but the new Cunarders to get nine knots more speed approximately will require more than four times as much horsepower. The great size of the two steamers under notice will be



CABLES FOR THE CUNARD EXPRESS LINE.

better understood by reference to the following tabular comparison of the big steamships of the world:

	Length over all.	Beam, ft	Depth, ft.	Displacement.	Horsepower.	Speed.
Great Eastern	692	83	57½	27,000	8,000	14.25
Lucania	625	65	42	19,000	20,000	22.01
Oceanic	704	68	49	28,500	28,000	19.59
Deutschland	686	67	42	23,000	37,500	23.51
Baltic	725	75	49	40,000	18.000	16.25
Kaiser Wilhelm II ..	706	72	52½	30,000	40,000	23.58
Amerika	680	74½	53	36,000	15,000	16.00
New Cunarders	776	88	60	43,000	75,000	25.00

Each of the new lines will carry 3,000 souls having accommodation for 500 first class, 500 second class and 1,200 third class passengers, and a crew of 800. Marine engineers predict that the two vessels will be the steadiest ships on the ocean. They will be fitted in a manner equal to the most gorgeous modern hotels. The decorations will consist of reproductions of the greatest works of art, while a system of lifts between the various decks will provide for the rapid transit of the passengers from one part of the ship to another. The first class dining saloon will be unprecedented in marine architecture. It will be a massive and pleasing apartment 125 ft. long, and 80 ft. wide, and will comfortably accommodate 500 persons at one meal. It will be lighted by a great dome extending up through the two decks above and crowned with a roof of cathedral glass.

More than one engineering record has been broken in the construction of the ships. The stern frames and brackets are the largest ever known, the former alone weighing 47 tons, and requiring no fewer than 69 tons of molten metal in the making. The actual beam of the new liners will be 88 ft. and for the first time the beam of the Great Eastern will be exceeded. So far as accommodation is concerned it is stated that unsurpassed attractiveness will be offered to all classes of passengers.

It is anticipated that a minimum speed throughout the entire voyage across the Atlantic of 24½ knots will be produced from the gigantic turbine engines which will develop nearly 80,000 I. H. P. An important element in the construction of both vessels is a double bottom 5 ft. 6 in. in depth between the outer and inner shells. With regard to the turbines it is claimed that one of the greatest triumphs of British marine engineering has been attained. The power will be divided into four units, each driving a separate propeller, and it is stated that even if one set of propellers should fail there will be sufficient power to drive the vessel at 22 knots per hour. Taking advantage of the great breadth of the vessels, the builders have placed the four turbines on the same platform, and each will drive its separate shaft. The turbines themselves are of enormous proportions. The drums are 12 ft. in length, by 8 ft. in diameter, and weigh 15 tons. The rotors for the low pressure turbines necessitated the casting of a steel ingot of 120 tons, the largest ever made. The ingot mold which weighs 180 tons, was filled with molten steel, and subjected to a total pressure of 12,000 tons. Owing to the width of beam also, the 23 double-ended and two single-ended boilers have been placed four abreast, leaving ample space for bunkers in the wings. They are of Scotch type and of huge proportions, so that a sufficient supply of steam can be raised in case of emergency.

The electrical installation to be fitted on board these ships will be the largest and most complete ever fitted on board ship. There are to be electric hoists for passengers, and stores, electric bells, radiators, etc., and nearly 5,000 lamps will serve for lighting. The watertight doors will be closed by electric connection, and there will be four searchlights on the bridge deck. The cables are also in keeping with the immense proportions of these steamers. The makers are Messrs. Brown, Lenox & Co., of South Wales, who it is interesting to note made the cables for the famous Great Eastern. This firm have not only forged the links of the chain, but have manufactured the iron bars and the crucible steel studs. The iron is 3¾ in. in diameter at the smallest part of the link, each link is about 22¼ in. in length, and with the cast steel stud weighs about 160 lbs. The Cunard company recently required three links to be tested to destruction, so three links were cut from the cable and sent to Lloyds proving house in Staffordshire. Under the admiralty proof strain of 198.8 tons, each link elongated nearly ¼ in. The statutory breaking stress of 265.7 tons was next applied, the result being a further elongation of the links of about ¾ in. Then an attempt was made to test the sample to destruction, but the full power of the machine of 350 tons failed to break it, indeed it is understood that the actual tension applied was over 370 tons. An examination of the links after this test showed no sign of fracture nor defect of any kind, although the stress applied was about 90 per cent above the admiralty proof stress.

H. H. Brigham, manager of the marine department of A. Booth & Co., Chicago, announces that his line will operate the steamers Soo City and Eastern between Mackinac island and Duluth via Washington and Tobin's harbor, Houghton, Hancock and Marquette.

The Great Northern liner Dakota has just concluded the run from Yokohama to Seattle in nine days and eleven hours, exceeding all former records by more than a day.

The tenth annual commencement of Webb's Academy and Home for Ship Builders, Fordham Heights, N. Y., was held on Thursday of this week.

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AROUND THE GREAT LAKES

The new lighthouse at the entrance of Kenosha harbor has been placed in commission.

Work on the proposed lighthouse at Milwaukee will not be undertaken until it is definitely determined whether the breakwater pier will be extended or not.

The Wisconsin & Michigan railway tug Ames, with two car ferries in tow, ran into the bridge at Sturgeon bay last week, doing considerable damage to the tug.

The United States government survey steamer General Williams was floated out of the Wolverine dry dock at Port Huron this week, after being lengthened 25 ft.

The MARINE REVIEW has an inquiry for two lake steamers, steel, 700 to 800 tons, suitable to be taken to the Pacific coast. Has anyone such steamers for sale?

Work will be begun shortly on the extension of the south harbor breakwater at Buffalo. Contract for the work has been awarded to the Canal Quarry Co., Buffalo.

The Montreal & Great Lakes Steamship Co. has been organized to operate steamers from Montreal to Fort William in the package freight and grain business.

The steamer Roman, of the Pittsburg Steamship Co.'s fleet, went ashore on Summer island during the fog on the upper lakes this week. She was en route to Escanaba light.

The steamer Harvey D. Goulder reached the head of the lakes on her maiden trip on May 31. The new steamer E. J. Earling left Duluth on her maiden trip June 1.

The steamer Howard L. Shaw, which was damaged in collision with the Coralia and her consort Maia, is undergoing repairs at the Cleveland yard of the American Ship Building Co.

The steamer Scottish Hero, which was brought from Scotland by the Canadian Lake & Ocean Navigation Co., has been cut in two in order to get through the Welland canal.

At the new Hanna coal dock at Duluth, 8,971 tons of coal were unloaded from the steamer W. H. Paine in 24 hours, using three Mead hoists. This is equal to 122 tons per hour for each hoist.

The wooden steamer Bulgaria, of the Corrigan fleet, stranded on Fisherman's shoal, Lake Michigan. She struck on a rocky bottom and immediately filled with water. The Bulgaria was bound for Green Bay with coal.

The steamer J. Gould, built in 1869, which has been idle at the Port Huron docks so long that it was believed her days of usefulness were ended, is being fitted out at the Bay City dry dock for service in the lumber trade.

The city of Manitowoc has voted to expend $50,000 for dredging in the harbor. The Wisconsin Central railway has leased 1,000 ft. of dock frontage to a coal company which will build a modern coal dock 1,000 ft. long and 100 ft. wide.

The Montreal corn exchange has decided to petition the Dominion government to build a two million bushel elevator at Port Colbourne. The government will also be petitioned to deepen the channel leading to the elevator at Port Colbourne to accommodate vessels with full cargoes.

The United States Steel Corporation has purchased a strip of land belonging to J. Robinet and F. Chappeaus at Sandwich for a consideration of $17,000. The corporation had an option on the land and on being refused an extension of time, took advantage of the option and bought the property outright.

The Pasadena, once one of the best known steamers on the lakes, has been converted into a barge at the yard of the Ship Owners' Dry Dock Co., Chicago. She will hereafter be towed by the Gladstone. The steamer M. B. Grover, recently converted into a tow barge, will be towed by the Alva. These vessels belong to the Bradley fleet.

Col. Charles E. L. B. Davis, United States engineer with headquarters at Detroit, is soliciting bids for the widening of the canal above the locks at Sault Ste. Marie. Bids will be opened by July 24. The improvement calls for an average additional width of 145 ft. to the present canal, beginning at the Poe lock. The length of the widened canal will be 3,900 ft. It is estimated that the work will cost about $1,500,000. Of this sum $600,000 is immediately available and the rest has been authorized.

The Canadian steamer Erin was sunk in collision with the steamer J. B. Cowle in St. Clair river opposite St. Clair last Thursday morning, the Erin being practically cut in two. The Erin was towing the barge Danforth and the boat was immediately lowered from the Danforth to rescue the crew of the Erin. Notwithstanding prompt action, however, five of the crew were drowned. The Erin was 174 ft. long and was owned by T. Conlin, Thorold, Ont. The Cowle was also injured but proceeded to Huron where she unloaded her cargo of ore. She will be repaired at the Toledo Ship Building Co.'s yard, Toledo.

All agreements with labor aboard ship have now been concluded. The last agreement was signed with the Marine Firemen, Oilers and Watertenders' Association during the present week, the union accepting last year's scale of wages and other conditions. The contract with the grain scoopers' union which was entered into last month has now been extended to include two years. This is in harmony with recent policy, and is one of the best moves that has been made on the lakes in recent years. It is now assured that there will be no trouble with labor on the lakes for the next two years.

The steamer Eugene Zimmerman, which was in collision with the steamer Saxona at the dyke in St. Mary's river, is now at the Cleveland yard of the American Ship Building Co. undergoing repairs. She is about the worst looking ship that ever presented herself at a ship yard for repairs. Practically her entire bow will have to be replaced. She was smashed so badly as to rip open the collision bulkhead which was the cause of her sinking so rapidly. A temporary bulkhead was built abaft the collision bulkhead in order to enable her to come down the lakes. It will take about a month to repair her and the damage will amount to at least $50,000.

The commission appointed by Governor Fred M. Warner, of Michigan, to celebrate the semi-centennial of the completion of the first canal at Sault Ste. Marie has decided upon plans for the erection of a monument in commemoration of the event. The monument will be a 42-ft. obelisk similar to Cleopatra's needle. It will be composed of a single piece of massive granite from the quarries of Connecticut. The top will be tipped with gilded copper and the historical tablets on the sides of the monument will go back to the time of Louis XVI. Of course, it is somewhat early to speak of unveiling plans, but the monument will probably be dedicated during the present year.

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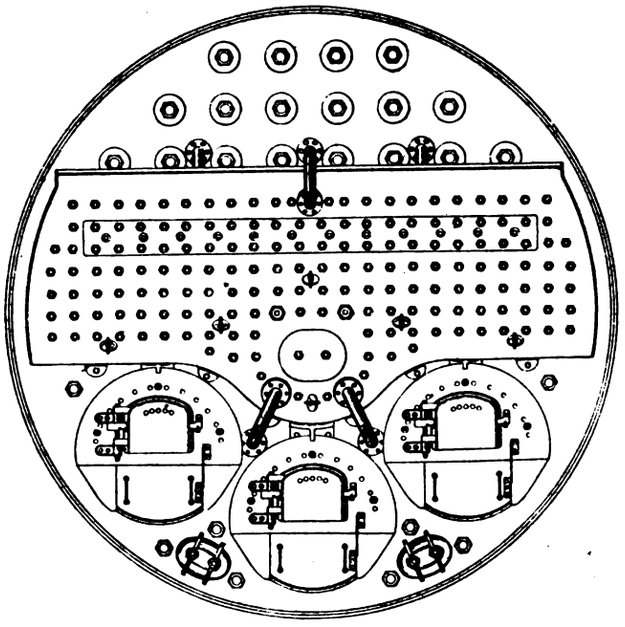
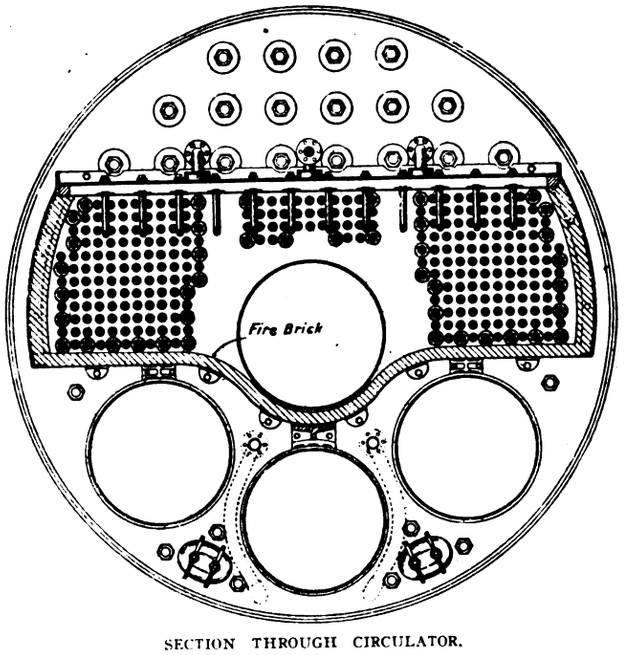
THE INGLIS MARINE STEAM BOILER.

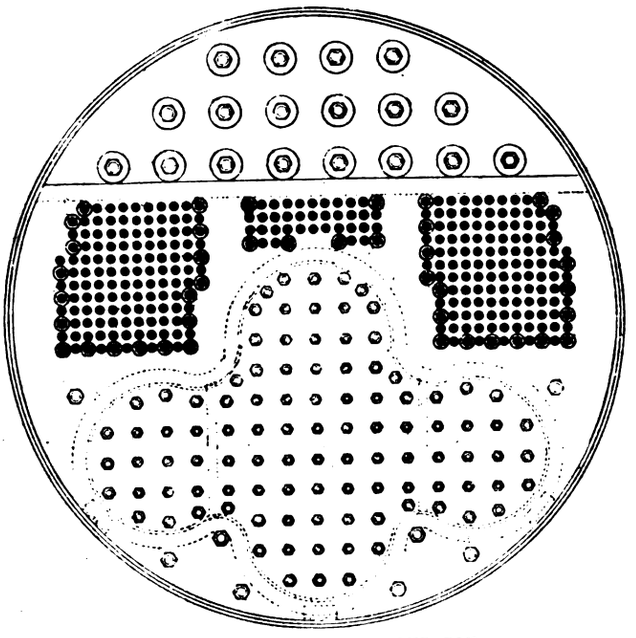
Exhaustive tests have been made by independent authorities with a new form of marine boiler, made and erected in Glasgow, and enclosed in an air-tight house for testing purposes, under conditions in all respects analogous to the "closed stokehold" system on board ship. The results of these tests form indisputable testimony to the fact that a new steam generator of striking efficiency is now readily available to the marine engineering world. The boiler in question is the Inglis patent steam boiler, the inventor being Mr. Inglis, a boilermaker of Airdrie, and the company now placing it on the market, the Inglis Boiler Syndicate, Limited, of 83 Renfield street, Glasgow. The boiler has been designed to increase the efficiency of the present cylindrical marine return-tube boiler—particularly when working under forced draught in a closed stokehold—and to overcome the disadvantages which are in some cases causing it to be replaced by the water-tube type of boiler. These objects, it is abundantly evident from the tests and reports which we have been privileged to examine, have been fully achieved, and marine and other engineers have now available a boiler with nearly all the advantages of both the cylindrical tank and the water-tube types, without the disadvantages appertaining to either.



FRONT ELEVATOR.

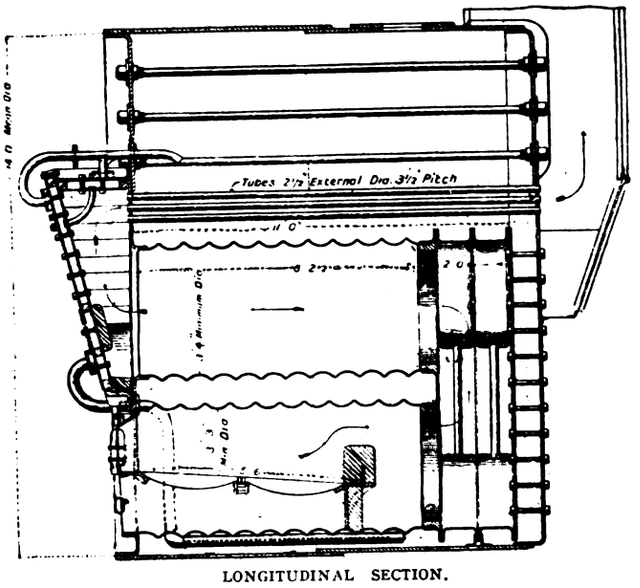


SECTION THROUGH CIRCULATOR.



SECTION THROUGH SMOKE BOX.

Exhaustive tests were made by five separate authorities quite independently of each other, with a boiler constructed from Mr. Inglis's designs, by Messrs. Denny & Co., Dumbarton. It is 11 ft. long and 14 ft. diameter, and has a heating surface of 2,620 sq. ft. (about 20 per cent more than an ordinary boiler of the same size), and 55 sq. ft. of grate area. From the sectional plans we are enabled to give herewith, it will be seen that there are three furnaces, of the same form, and placed as in other cylindrical boilers. Instead, however, of returning the gases from each furnace by way of a separate combustion chamber to the tubes, and thence to an uptake over the furnace doors, the furnaces are led into one common combustion chamber at the back, of special design, from which a cylindrical corrugated combustion chamber, practically similar to the furnaces, leads all the gases



LONGITUDINAL SECTION.

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back to the front of the boiler where they then enter the tubes (which extend the full length of the boiler) and are conveyed to the smokebox at the back of the boiler.

It will at once be seen that the outstanding superiority of the Inglis boiler over an ordinary chamber marine boiler consists in the great combustion chamber provided in the form of what is practically a fourth flue. Two little peep-holes were provided at the back of the boiler, through which the combustion of the gases in this chamber was examined and found complete. The fact that the products from all the furnaces meet freely here is beneficial, as it gives an opportunity for the cooler gases from a surface which has just been fired to be heated and burnt by that from the other grates, and thus the emission of smoke is obviated. The fact that the temperature of the gases is reduced some 280 to 300 degrees in passing through the extra combustion chamber shows the great advantage of its presence. It causes at the same time the temperature at tube-plate to be constant, and unaffected by the variations due to the opening of the furnace doors when firing. In this way the great cause of leaky tube ends is obviated. The disposal of ashes and dust takes place in this chamber, and there is consequently no bird's nesting of the tubes.

Good circulation, as well as good combustion, is provided for in the design. The front chamber is, as will be gathered from our illustrations, enclosed by a water wall in front and on top. The lower part is connected by two pipes with water circulators, which lie, one on each side under the lowest flue. The upper part is provided with three pipes, which deliver near the water line. The water is thus drawn from the coolest part of the boiler, heated, and delivered near the surface. The back combustion chamber is shaped as shown in dotted lines in one of the end views given in our illustration. To give it the necessary strength the chamber is made in two parts, and in this way it is provided with a central circumferential flange. Four vertical tubes join it across the narrowest part, their main object being to prevent the collection or deposits in the slight hollows at the shoulders, and to aid circulation. Examination has shown that the circulation of them is very active, and deposition is rendered impossible.

Amongst individuals or firms who have tested the Inglis boilers are: Messrs. Burstall & Monkhouse, London; Prof. Stanfield, Herion Watt College, Edinburgh; Messrs. John Brown & Co., Clydebank; Messrs. Denny & Co., Dumbarton; and the Fairfield Engineering & Ship Building Co., Govan. The tests made independently by these authorities involved coal consumptions varying between 16.2 lbs. per square foot of grate, with four-tenths in. of air pressure, up to nearly 50 lbs. of coal, with 3 in. of air pressure. It is clearly demonstrated by these tests that the thermal efficiency of the boiler is very high, as much, according to Messrs. Denny & Co.'s trial, as 89.5 per cent. The tests were all of good duration; stoking was wholly by hand, and there was an entire absence of smoke, except in a few cases immediately after firing.

The substance of the reports of the several authorities named may be enumerated. Messrs. Burstall & Monkhouse state that their trials showed that the thermal efficiency of the boiler was exceedingly high, even when working at the highest rate of combustion; that the steam given off was to all intents and purposes absolutely dry; that there was practically no smoke at the top of the chimney, smoke appearing only at the moment of firing, and being all cleared off before the end of one minute. Professor Stanfield reports that there appeared to be a more equable distribution of strain in the Inglis than in the ordinary Scotch boiler, the temperature was more uniform throughout, the circulation was most efficient, and the temperature of the escaping flue gases was remarkably low, even when working with a pressure of 3 in. of water in the stokehold. He detected no leakage in any of the tubes. Steam had been raised from cold water in one hour 21 minutes after the fires were lighted, under circumstances which made this a most satisfactory performance. The combustion was nearly perfect, and there was practically no smoke emitted when burning about 20 lbs. of coal per square foot of grate area per hour. It was also clearly proved that the boiler could be forced without damage to itself, and with economy. The reports of Messrs. Denny & Co., the Fairfield Co., and Messrs. John Brown & Co., all refer in most favorable terms to the high evaporative efficiency of the boiler, the perfection of combustion, the smokelessness of working, and the high capability of the boiler to stand severe forcing.

As regards the important question of the weight of the Inglis boiler, as in the case of the experimental boiler tested, this is estimated at 62½ tons complete to root of funnel, including circulator, internal and external pipes for same, mountings, brickwork, etc., but excluding all auxiliary machinery in stokehold and funnel, and taking the water hot at the working level, 7 in. above tubes. Allowing an extra 6½ tons for boiler weights as excluded in above, taking, say, an installation of eight boilers, the total weight would be about 69 tons. This would give 443 lbs. of steam per ton of stokehold weights on the basis of one of Messrs. John Brown & Co.'s trials, where 30,504 lbs. of water were evaporated per hour from and at 212 degrees F. This, as regards weight, compares favorably even as against water-tube boilers.

The high reputation of the firms who subjected the Inglis boiler to thorough tests, and the favorable character of the reports, have won from engineers everywhere inquiries and keen interest in the subject. Proposals have been received from a large firm of American ship builders to work under the American patents of the Inglis Boiler Syndicate. The syndicate, we understand, are arranging to install a boiler into one of the well known Clyde river steamers, and expect to have it working about the beginning of next year.

DESTROYED BY FIRE.

Very recently, the Key Route Co., of San Francisco, met with a heavy loss by fire. This loss was sustained long after the great conflagration that swept the city. This company owns three very fast ferry boats that ply between San Francisco and Oakland. These vessels are San Jose, Yerba Buena and San Francisco. Within the last twelve months the company began building two more boats to add to their present fleet. One of these new craft was launched from the Dickie ship yard in Oakland, a few months ago. Subsequently this boat was towed over to receive her boilers and machinery, at the Union Iron Works, at San Francisco. About a week ago the vessel was discovered on fire shortly after midnight. Despite every possible effort, the vessel was totally destroyed—burning down to the water's edge. The total loss will reach $200,000, on which there is but comparatively small insurance. How the fire caught is a mystery. It was first discovered by one of the watchmen at the Union Iron Works. The uninclosed hull of the other new boat on the ways at the Dickie yard was knocked clear off of the blocks—thrown over on its side—by the violent earthquake. Fortunately, the hull escaped severe damages, and was got back into position without much trouble and cost to the company.

Cobb, Butler & Co., Rockland, Me., have contracted to build a five-masted schooner for Maine and Boston parties.

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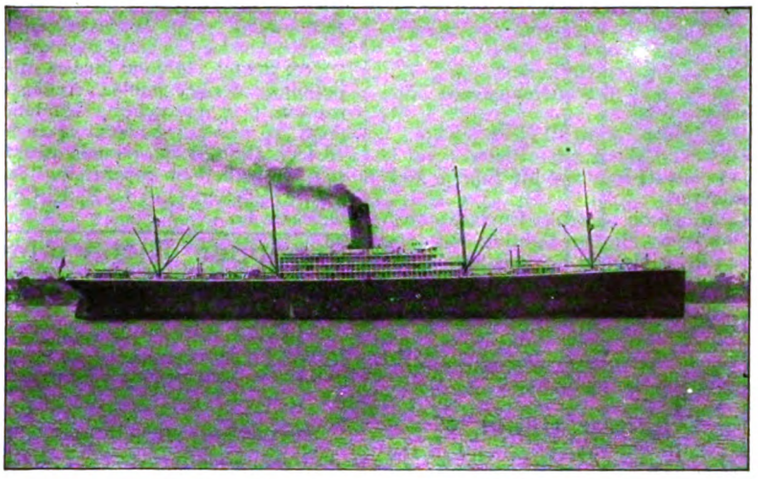
Hyde Windlasses and Capstans



Steamship Minnesota equipped with Hyde Windlass and Capstans.

Selected for the Minnesota and Dakota of the Great Northern Steamship Co.'s fleet—the largest vessels ever built in the United States. They are also being installed on nearly all of the vessels now building for the Navy Department, Revenue Cutter service, Lighthouse Board and the United States Coast Survey.

Reason—Their Superiority

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DIRECT REPPESENTATIVE OF LEADING AMERICAN AND FOREIGN UNDERWRITERS

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IRON STEEL
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The Water Light

Self-Igniting Inextinguishable

For

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Send for Simple.

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THE MARINE TORCH CO.

BALTIMORE, MD.

Especially approved by The British Board of Trade, either of Life Buoy Lights or Deck Flare.

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WANTED and FOR SALE Department.

PROPOSALS.

U. S. Engineer Office, Jones Building, Detroit, Mich., June 4, 1906. Sealed proposals for widening St. Marys' Falls Canal will be received at this office until 2 p. m., July 24, 1906, and then publicly opened. Information furnished on application. Chas. E. L. B. Davis, Col. Engrs.

U. S Engineer Office, Room 508, Federal Bldg., Chicago, Ill., May 26, 1906. Sealed proposals for concrete superstructure in Chicago Harbor, Ill., will be received here until noon, June 30, 1906, and then publicly opened Information on application. W. H BIXBY, Lt. Col., Engrs.

FOR SALE.

Diving Suit.

FOR SALE.—Diving Suit, Pump and complete outfit, used but once, good as new; a bargain. E. L. Strong, 112 Superior St., Cleveland, O.

For Sale or Charter for the Season.

Commodious Steam Yacht, 75 ft. long, 18 ft. beam, 6½ depth of hold. Two staterooms and finest outfit, including electric light plant, search light, and power launch. Triple expansion engine, safety boiler. Cheap and easy steamer. Inquire of R. J. Cram, Port Huron, Mich.

For Sale.

Scotch Marine Boiler 6 x 8 feet and two 11 x 12 Marine Engines complete. Good bargain. AMERICAN CRUSHED STONE COMPANY, Chicago, Ill.

FOR SALE.

For Sale.

1,000 h. p. fore and aft Neafie & Levy compound Engine; surface condenser; independent pumps.
Two 12-foot Scotch Boilers.
One 13½-foot Scotch Boiler.
One 10 16-25 x 16 triple expansion Engine.
Three 150-h. p. Almy Boilers.
One 200-h. p. Tregurtha Boiler.
One 14 30 x 24 fore and aft Engine and condenser.
One Williamson steering Engine.
One 10 k. w. electric lighting Set.
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Steamer E. F. Gould, length 137 ft., width 28 ft, depth 8 ft. 5 in, tonnage 261 tons. Boiler, engine and hull in good condition. First-class, complete sand pumping outfit now installed on boat, will sell with boat if so desired. Apply

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147 ft. long.
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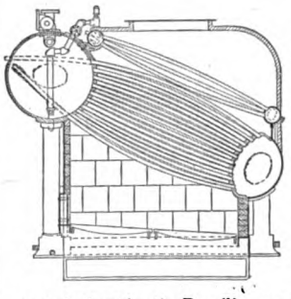
THE MOSHER PATENT WATERTUBE BOILER



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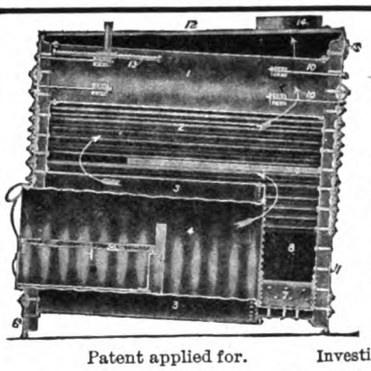

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Standard corrugated furnaces.

Patent applied for. Investigate before buying any other.

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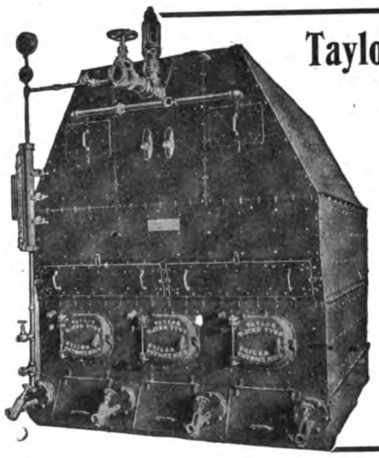

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Fire box, combustion chamber, and course for the furnace gases similar to the Scotch Marine.
Free circulation type.

Send for full description.

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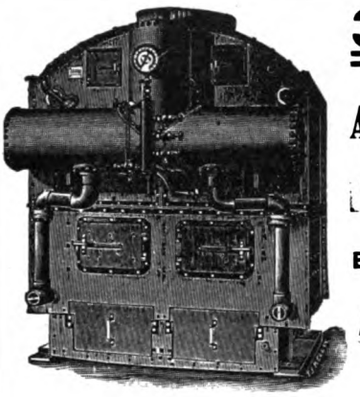

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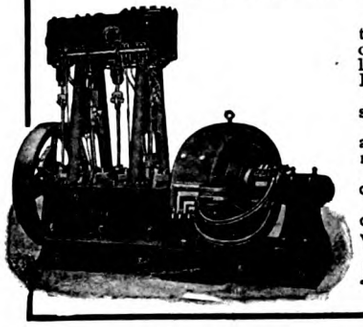

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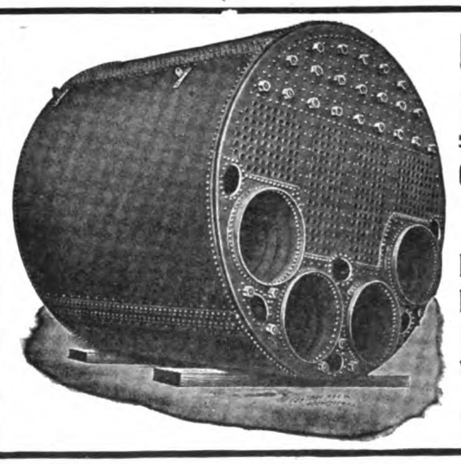

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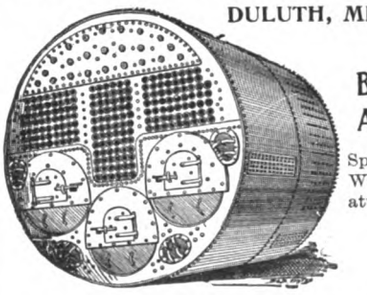

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See accompanying index of Advertisers for full addresses of concerns in this directory.

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